5. Detailed Evaluation of Alternatives

Section 5 presents the detailed evaluation of alternatives required by the NCP in 40 CFR 300.430(e)(9). The remedial alternatives were described in detail in Section 4 and are only briefly described in this section. Although the alternatives have been developed to a significant level of detail in this report and in technical memoranda presented in the appendices, it should be noted that the level of detail at this stage is still considered conceptual. Design details and cost estimates will continue to be refined following selection of an alternative and up until final implementation of the remedial action. Section 5.3 provides a comparative analysis that focuses on the relative performance of each alternative against the evaluation criteria.

5.1 Introduction of Evaluation Criteria

The NCP specifies nine criteria for evaluating remedial alternatives [40 CFR 300.430(e)(9)]. The nine criteria fall into three groups: threshold criteria, primary balancing criteria, and modifying criteria. The first two criteria are the threshold criteria, which each alternative must meet to be eligible for selection. The next four criteria are the primary balancing criteria, which are used to weigh major trade-offs among alternatives. The final two criteria are the modifying criteria, which may be considered to the extent that information is available during the FS, but can be fully considered only after receipt of state and public comments in response to the RI/FS. In the final balancing of trade-offs between alternatives upon which the final remedy selection is based, modifying criteria are of equal importance to the balancing criteria.

This section consists of an assessment and comparative analysis of the alternatives with respect to the two threshold criteria and the five balancing criteria. The two modifying criteria, State Acceptance and Community Acceptance, will be evaluated by EPA following receipt of state and public comments at community meetings, agency meetings, and written comments submitted by the state and public in response to the RI/FS. All nine of the criteria are described below:

1. Overall Protection of Human Health and the Environment (Threshold Criterion)

The NCP requires that alternatives "be assessed to determine whether they can adequately protect human health and the environment, in both the short- and long-term, from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the site by eliminating, reducing or controlling exposure...."

2. Compliance with Applicable or Relevant and Appropriate Requirements (Threshold Criterion)

The NCP [40 CFR 300.430(e)(9)(B)] requires that alternatives "be assessed to determine whether they attain applicable or relevant and appropriate requirements under federal environmental laws and state environmental or facility siting laws or provide grounds for invoking one of the waivers under paragraph (f)(1)(ii)(c) of this section." It is important to note that the ARARs identified in the discussion below for each alternative are preliminary, and that EPA will make the final determination of applicable ARARs as part of the remedy selection. In addition to ARARs, the TMDL, which was identified as a potential TBC, is also discussed below.

3. Long-Term Effectiveness and Permanence (Balancing Criterion)

The NCP in 40 CFR 300.430(e)(9(C) requires that alternatives be:

"...assessed for the long-term effectiveness and permanence they afford, along with the degree of certainty that the alternative will prove successful. Factors that shall be considered, as appropriate, include the following:

1. Magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities. The characteristics of the residuals should be considered to the degree that they remain hazardous, taking into account their volume, toxicity, mobility and propensity to bioaccumulate.

2. Adequacy and reliability of controls such as containment systems and institutional controls that are necessary to manage treatment residuals and untreated waste. This factor addresses in particular the uncertainties associated with land disposal for providing long-term protection from residuals; the assessment of the potential need to replace technical components of the alternative, such as a cap, a slurry wall, or a treatment system; and the potential exposure pathways and risks posed should the remedial action need replacement."

4. Reduction of Toxicity, Mobility, or Volume through Treatment (Balancing Criterion)

The NCP in 40 CFR 300.430(e)(9)(D) requires that:

"The degree to which alternatives employ recycling or treatment that reduces toxicity, mobility, or volume shall be assessed, including how treatment is used to address the principal threats posed by the site. Factors that shall be considered, as appropriate, include the following:

1. The treatment or recycling processes the alternatives employ and materials they will treat;

2. The amount of hazardous substances, pollutants, or contaminants that will be destroyed, treated, or recycled;

3. The degree of expected reduction in toxicity, mobility, or volume of the waste due to treatment or recycling and the specification of which reduction(s) are occurring;

4. The degree to which the treatment is irreversible;

5. The type and quantity of residuals that will remain following treatment, considering the persistence, toxicity, mobility, and propensity to bioaccumulate of such hazardous substances and their constituents; and

6. The degree to which treatment reduces the inherent hazards posed by principal threats at the site."

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5. Short-Term Effectiveness (Balancing Criterion)

The NCP in 40 CFR 300.430(e)(9)(E) requires that:

"The short-term impacts of alternatives shall be assessed considering the following:

1. Short-term risks that might be posed to the community during implementation of an alternative;
2. Potential impacts on workers during remedial action and the effectiveness and reliability of protective measures;
3. Potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation; and
4. Time until protection is achieved."

6. Implementability (Balancing Criterion)

The NCP in 40 CFR 300.430(e)(9)(F) requires that:

"The ease or difficulty of implementing the alternatives shall be assessed by considering the following types of factors as appropriate:

1. Technical feasibility, including technical difficulties and unknowns associated with the construction and operation of a technology, the reliability of the technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy;
2. Administrative feasibility, including activities needed to coordinate with other offices and agencies and the ability and time required to obtain any necessary approvals and permits from other agencies (for off-site actions);
3. Availability of services and materials, including the availability of adequate off-site treatment, storage capacity, and disposal capacity and services; the availability of necessary equipment and specialists, and provisions to ensure any necessary additional resources; the availability of services and materials; and availability of prospective technologies."

7. Cost (Balancing Criterion)

The NCP in 40 CFR 300.430 (e)(9)(G) requires that:

"The types of costs that shall be assessed include the following:

1. Capital costs, including both direct and indirect costs,
2. Annual operation and maintenance costs, and
3. Net present value of capital and operation and maintenance costs."

The detailed evaluation of costs that were developed pursuant to this requirement allows evaluations and comparisons of the costs of the respective alternatives. The detailed analysis presented here draws no conclusion as to the "cost-effectiveness" of the respective alternatives. The cost-effectiveness finding, which is required by CERCLA, will be determined in the remedy selection phase.

For detailed analysis of alternatives, EPA guidelines recommend that costs be developed with an accuracy of plus 50 percent to minus 30 percent (EPA, 2000f). Cost estimates developed in the analysis of alternatives include capital , and annual O&M costs.

Capital costs are those expenditures that are required to construct a remedial action. Capital costs include all labor, equipment, and material costs, including contractor markups such as overhead and profit, associated with mobilization/demobilization and construction. Capital costs also include expenditures for professional/technical services necessary to support construction of the remedial action.

Annual O&M costs are those costs necessary to ensure the continued effectiveness of the selected remedy following construction. Annual O&M costs include all labor, equipment, and material costs, including contractor markups, associated with activities such as monitoring, operating and maintaining remedial systems, and sludge disposal. Annual O&M costs also include expenditures for professional/technical services necessary to support O&M activities.

All future costs are reduced to net present values to allow equitable comparison of individual remedial alternatives. Net present value costs evaluate expenses over time by discounting future costs to a common base year using a discount rate. The discount rate used is 7 percent, and the present worth analysis period is 30 years for each alternative.

8. State Acceptance (Modifying Criterion)

The NCP in 40 CFR 200.430(e)(9)(H) requires that:

"Assessment of State concerns may not be completed until comments on the RI/FS are received but may be discussed to the extent possible in the proposed plan issued for public comment. The state concerns that shall be assessed include the following:

1. The state's position and key concerns related to the preferred alternative and other alternatives, and
2. State comments on ARARs or the proposed use of waivers."

IDEQ has participated with EPA and other parties over the past few years in the site investigations and analyses associated with this RI/FS, and is in agreement with the alternatives developed in this feasibility study. Issues of concern and goals expressed by the state during the development of this RI/FS include maximizing the extent of developable land within the Bunker Hill Superfund site, maximizing the reduction in the quantity of AMD discharge by source control measures, and minimizing the costs of long-term O&M that may be borne by the state or private parties.

9. Community Acceptance (Modifying Criterion)

The NCP in 40 CFR 300.430(e)(9)(I) requires that an assessment of community acceptance:

"Includes determining which components of the alternatives interested persons in the community support, have reservations about, or oppose. This assessment may not be completed until comments on the proposed plan are received."

As mentioned previously, evaluations of the two final evaluation criteria, State Acceptance and Community Acceptance, are not performed in this document. The NCP provides for opportunities for the public and the state to participate in a review of the alternatives evaluation in a public meeting. The NCP also provides state agencies and the public the opportunity to comment on a proposed plan for remedial action. Final evaluations of the State Acceptance and Community Acceptance criteria will be performed after allowing for state and community input into the remedy selection process. These evaluations are considered during remedy selection.

5.2 Individual Analysis of Each Alternative

This section provides an analysis of each of the alternatives relative to the two threshold criteria and five balancing criteria described above. Each analysis begins with a description of the alternative followed by a criterion-by-criterion evaluation of the alternative.

5.2.1 Alternative 1—No Further Action

5.2.1.1 Description

The NCP in 40 CFR 300.430(e)(6) requires preparation and development of a "No-Action" alternative. With respect to evaluating the alternative's potential for meeting the remedial action objectives for the Bunker Hill mine water, the no-action alternative should be considered as "no further action." The no-action alternative is commonly used as a baseline alternative against which other alternatives are judged. This alternative does not include any additional remediation activities. No CTP repairs would be made, and no sludge replacement facilities would be constructed when the current facility is full, which is expected to be within 3 to 5 years. At this point the CTP would be shut down because it cannot function without sludge disposal. This will result in untreated AMD being discharged into Bunker Creek. At this point all other mine water management components would be shut down, including in-mine AMD collection activities, unless unilaterally continued by the mine owner for mining purposes. Thus, no remedial action funds would be expended for the No Further Action alternative once the sludge impoundment is full.

5.2.1.2 Overall Protection of Human Health and the Environment

Discharge of untreated AMD into Bunker Creek will endanger human health and result in acutely toxic conditions for aquatic life in the creek. Metal concentrations in the SFCdA River downstream of the confluence with Bunker Creek will increase and will result in severe aquatic toxicity (see Table 2-3).

5.2.1.3 Compliance with ARARs

ARAR compliance is addressed by considering chemical-specific, location-specific, and action-specific ARARs separately. Section 2.6 provides a detailed discussion of ARARs that may be applicable.

Chemical-Specific ARARs. The ARARs analysis presented several legal standards that specify water quality goals. The No Further Action alternative will not meet these goals. This alternative will result in toxic water quality in Bunker Creek and in the SFCdA River.

Location-Specific ARARs. Section 2.6 describes possible location-specific ARARs. This alternative will result in degradation of aquatic habitat within Bunker Creek and the SFCdA River. Thus, it will not be in compliance with state and federal fisheries and wildlife protection laws.

Action-Specific ARARs. Section 2.6 describes possible action-specific ARARs. None of these are applicable to this alternative because no actions would be taken.

5.2.1.4 Long-Term Effectiveness and Permanence

Magnitude of Residual Risk. The No Further Action alternative will exacerbate the present risks. Once the CTP quits operating (within 3 to 5 years), the untreated AMD will be discharged to Bunker Creek, resulting in greatly increased pollutant loads into the creek and the SFCdA River. Sludge production and accumulation at the CIA would continue at present rates, estimated at 15,000 to 18,000 cubic yards per year, until the existing sludge impoundment is full (within 3 to 5 years). Once full, it would not be capped under this operable unit, leaving open and exposed sludge and a conduit for continued leaching into the underlying tailings. Capping would need to occur under another site operable unit.

Adequacy of Reliability and Controls. This alternative does not have adequate reliability or controls.

5.2.1.5 Reduction of Toxicity, Mobility, or Volume Through Treatment

Treatment Process and Remedy. The existing CTP lime neutralization treatment process removes heavy metals by precipitation as hydroxides. Acidity is removed by lime addition, which converts the hydrogen ions to water. The pH of the effluent is alkaline and in the 8 to 9 range. The precipitated metals forms a sludge that is pumped from the clarifier/thickener at about 1 to 5 percent solids by weight to the unlined sludge disposal bed on the CIA, where the sludge dries by gravity draining and evaporation to about 30 percent solids. The sludge accumulates at about 15,000 to 18,000 cubic yards per year. Once the sludge impoundment is full (3 to 5 years) the CTP will need to be shut down because it cannot operate without sludge disposal.

Amount of Hazardous Material Destroyed or Treated. The entire mine water flow from the Kellogg Tunnel is collected and treated in the CTP. Using the values listed in Table 1-1, the Kellogg Tunnel portal discharges about 2,500 lbs/year of cadmium, 4900 lbs/year of lead, and 1,130,000 lbs/year of zinc. The treatment process removes all of the acidity, over 99 percent of the cadmium and zinc, and about 85 percent of the lead based on the values listed in Tables 1-1 and 1-2. However, at these removal efficiencies, the CTP will not attain the TMDL or all state water quality criteria in the intervening 3 to 5 years before it is shut down. Once shut down, all of the AMD will enter Bunker Creek untreated.

Reduction of Toxicity, Mobility, or Volume. The current treatment process substantially reduces the toxicity and mobility of the metals, although insufficient to be in compliance with all state and federal water quality criteria or attain the TMDL. The metals are dissolved in the mine water at low pH conditions. In the dissolved form the metals have the greatest toxicity and mobility. The precipitated metals are immobilized in the sludge under alkaline conditions and removed from contact with water, people, and wildlife, reducing or removing the toxicity. Once the CTP is shut down, the toxicity and mobility of the metals will not be reduced.

Irreversibility of the Treatment. The current treatment process is reversible. Metals in the sludge will have the potential to leach back into solution because a low-permeability cover system will not be placed over the top of the sludge impoundment when it is full. Once the CTP is shut down there will be no treatment, so irreversibility will be moot.

Type and Quantity of Treatment Residual. The treatment residual of concern is the sludge, estimated to accumulate at between 15,000 and 18,000 cubic yards per year for the remaining 3 to 5 years until the CTP is shut down because of the lack of sludge disposal space.

5.2.1.6 Short-Term Effectiveness

Protection of the Community During Remedial Actions. This alternative does not contain any new remedial actions. The community will be at higher risk from uncontrolled discharge of AMD into Bunker Creek during the 3- to 5-year period until the CTP is shut down, and then at much higher risk afterward. There will be no repairs made at the CTP during the 3- to 5-year period; thus, it could break down or fail before the 3- to 5-year period is up.

Protection of Workers During Remedial Actions. This alternative does not include any remedial actions, so this evaluative criterion does not apply.

Environmental Impacts Associated with Construction. This evaluative criterion does not apply.

Time Until Remedial Response Objectives are Achieved. The No Further Action alternative will not achieve any of the remedial response objectives.

5.2.1.7 Implementability

Ability to Construct and Implement Technology. Administrative implementability of the No Further Action alternative will be very difficult given the significant environmental consequences.

Reliability of Technology. This is an unreliable alternative. The CTP will be shut down, resulting in no treatment after 3 to 5 years. It could fail sooner because no repairs will be made.

Ease of Undertaking Additional Remedial Actions, If Necessary. Implementation of the No Further Action alternative should not provide a serious impediment to other remedial actions that may be necessary, although they would be inconsistent with the philosophy of this alternative.

Ability to Monitor Effectiveness of Remedy. Monitoring will be conducted following current practices until the CTP is shut down, at which point all monitoring will cease.

Coordination with Other Agencies. Considerable coordination would be required to implement this alternative, given the environmental consequences.

Availability of Treatment, Storage Capacity, and Disposal Services. The existing sludge disposal capacity will be consumed in 3 to 5 years, at which time the CTP will be shut down because it cannot operate without sludge disposal.

Availability of Necessary Equipment and Specialists. No new materials or workforce are needed to implement the No Further Action alternative.

Availability of Prospective Technologies. No new technologies are required for this alternative.

5.2.1.8 Cost

Table 5-1 summarizes the order-of-magnitude (+50 to –30 percent) cost estimates for this alternative. The costs are summarized by remedy component. A cost period of 4 years is assumed for all components because, for this alternative, no remedial actions will continue once the existing sludge impoundment is full. Additional cost detail is included in Appendix G.

5.2.2 Alternative 2—Treatment Only

5.2.2.1 Description

Alternative 2, Treatment Only, consists of an updated and improved treatment plant, but no mitigations for reducing infiltration to the mine and the volume of AMD from the Kellogg Tunnel. The proposed treatment plant is sized to accommodate a peak inflow of 5,000 gpm, large enough to treat all previously recorded Kellogg Tunnel flows except for infrequent high peak flows (see Figure 2-15). These would be stored either in the lined pond or in the mine for later extraction and treatment. Monitoring will be conducted at the Kellogg Tunnel portal and at the CTP. Sludge would be disposed of using one of the following options:

Option A: Disposal of raw sludge in onsite sludge disposal beds located on the CIA that both dewater and permanently store the sludge

Option B: Mechanical sludge dewatering and disposal of dry sludge in an offsite landfill

Option C: Disposal of raw sludge in onsite sludge disposal beds located above the smelter closure area

Option D: Sludge drying using sludge drying beds on the CIA and annual excavation and disposal of dry sludge in an onsite landfill located above the smelter closure area

5.2.2.2 Overall Protection of Human Health and the Environment

Alternative 2 is expected to be protective of human health and the environment for mine water flows up to 6,750 gpm. The treatment plant will be able to treat 5,000 gpm, and up to 1,750 gpm can be stored in the mine. Flows in excess of 5,000 gpm are expected to be very infrequent and have a short duration based on the historical data. Referring to Figure 2-15, which lists Kellogg Tunnel hydrographs for 16 years, it can be seen that 5,000 gpm was exceeded five times, with no exceedance over 6,700 gpm. Four of these events occurred during the 1973 WY, and the fifth was during the 1974 WY. Table 2-1 lists the estimated Kellogg Tunnel flow return intervals. A flow in excess of 5,000 gpm has an estimated return interval of about 13 years, with a probability of occurrence in any year of about 8 percent.

All four sludge management options are expected to be protective. There is minor risk that the sludge could leak from the lined disposal units. For options A, C, and D, which use onsite disposal, risks of leakage will be minimized through use of liners and a filtrate collection system. The filtrate will be collected and treated. Land use restrictions would be needed to assure the viability of containing the treatment sludge and preventing dissolution.

For options A and C, one sludge bed will be continuously open to the atmosphere. Fencing and gates will keep out the public. If the surface of the sludge dries out, wind may pick up and transport dust. Based on experience at the existing sludge bed, the potential for wind erosion is low because the surface of the sludge typically remains moist from ongoing sludge placement.

For Option B, the sludge will be mechanically dewatered and hauled to an offsite landfill. The filtrate from mechanical dewatering will be collected and retreated. The sludge will be hauled on public streets and highways. Risk from exposure is considered low because the loads would be covered and transported in accordance with applicable standards.

5.2.2.3 Compliance with ARARs

Chemical-Specific ARARs. Based on the treatability testing results, the anticipated CTP effluent quality should meet most of the potentially applicable surface water requirements, as well as the TMDL discharge levels for the CTP. The TMDL has been identified as a TBC.

The primary goal for water quality is compliance with Idaho water quality standards (WQSs) that apply to Bunker Creek and the SFCdA River. WQS for cadmium, lead, and zinc are achieved through implementation and achievement of the TMDL. By achieving the TMDL, the Bunker Hill mine water remedy achieves requirements of the Idaho WQSs for these three pollutants.

Table 5-2 compares the treatability study results for metals against the potential State of Idaho chemical-specific surface water ARARs for contaminants of concern. The results suggest the CTP effluent will meet requirements for arsenic, cadmium, copper, lead, silver, and zinc (note: for cadmium, lead, and zinc, the TMDL levels differ from the chemical-specific surface water requirements). Based on the available data, it is uncertain whether the requirements for mercury, selenium, and thallium will be consistently met. Results suggest that the mercury limit of 0.012 μg/L may be exceeded slightly. The treatability results for selenium show that it was not detected above 9.6 μg/L. Because the water quality criteria is 5 μg/L, the treatability study results do not have low enough detection limits for direct comparison. Comparison against the thallium criteria is also difficult for the same reason; however, in general, the results suggest that the CTP discharge will either meet, or be very close to meeting, the limits for mercury, selenium, and thallium.

The other potential surface water ARARs that the CTP effluent may not consistently meet based on available information are temperature, dissolved oxygen, and pH. The temperature criterion is 22 degrees Celsius (C) or less, with a maximum daily average of no

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greater than 19 degrees C (see Table 2-6). Effluent from the existing CTP often exceeds 19 degrees C during summer months. With the addition of filters, the increase in mechanical energy required to pass water through the filters may increase the temperature in the discharge. For dissolved oxygen, the criterion is >6 mg/L (see Table 2-6). The AMD has chemical oxygen demand because of dissolved ferrous iron and manganese. Although aeration will be conducted within the treatment process, there may be insufficient oxygen transfer to the liquid to increase the dissolved oxygen to greater than 6 mg/L. For pH, the Idaho surface water criterion is between 6.5 and 9.5 pH units (see Table 2-6). The BPT and BAT pH criteria (see Table 2-10) specify a pH range of 6.0 to 9.0. The CTP operational pH setpoint is expected to be in the vicinity of 9.5, which is above the 9.0 criterion. Although it is likely that the pH will be less than 9.0 at the discharge, it is uncertain based on the treatability data.

The foregoing discussion suggests that the effluent from the upgraded CTP will either be in compliance with, or nearly in compliance with, all potentially applicable surface water ARARs. Performance monitoring of the upgraded full-scale CTP is needed to further assess compliance, and to determine if additional process changes or treatment schemes should be considered.

Location-Specific ARARs. Alternative 2 actions are not expected to influence archaeological and/or historic sites of significance, and will not involve construction activities that might degrade Bunker Creek. The possible relocation of the CTP discharge point may be favorable to the creek if it is moved further east, because more habitats would be created during the dry periods when the creek flow consists primarily of CTP effluent. No remedial actions would be implemented that might affect relevant floodplains or wetlands. The residual metal in the CTP discharge is expected to have negligible effect on species considered under the Endangered Species Act (ESA), and is actually expected to dilute concentrations of cadmium, lead, and zinc in the SFCdA River.

EPA is consulting with the United States Fish and Wildlife Service (USFWS) on potential impacts to endangered or threatened species or their habitats resulting from any construction activities associated with this remedy. As a result of this consultation process, measures would be taken to identify and remediate any impacts.

Action-Specific ARARs. The construction work associated with the remedial activities is expected to be in compliance with action-specific ARARs.

5.2.2.4 Long-Term Effectiveness and Permanence

Magnitude of Residual Risk. Alternative 2 employs no actions to reduce the quantity of mine water discharging from the mine. However, the treatment plant is sized at 5,000 gpm, which is expected to be sufficient for all Kellogg Tunnel flows except for the infrequent peak flows.

There is some risk that much higher flows could discharge from the mine as they have in the past, as discussed in Section 5.2.2.2. The peak mine water flow recorded to date is estimated at 6,700 gpm. Table 2-1 shows the estimated Kellogg Tunnel flow return intervals. The estimated 50-year return interval peak flow equals 7,140 gpm, and the estimated 100-year return interval peak flow equals 8,320 gpm. Typically, peak flows are of short duration. Although sufficient capacity exists in the mine to store peak flows of this magnitude, the in-mine system to divert gravity flows into the mine pool has a maximum capacity of

1,050 gpm. Shutting off the mine pool pumps will decrease the Kellogg Tunnel flow by an additional 700 gpm. Thus, the total in-mine capacity to reduce Kellogg Tunnel flows is 1,750 gpm. The combined treatment and in-mine storage capacity is 6,750 gpm.

Flows in excess of 6,750 gpm could be stored in the lined pond, but it may not have sufficient capacity if the flows are of long duration. For example, to manage the 8,320 gpm 100-year return interval flow, 1,570 gpm (8,320 – 6,750 gpm) would need to be stored in the lined pond. The lined pond capacity (assuming it is cleaned out and empty to begin with) is 7 million gallons. This would provide 3 days of storage for the 1,570 gpm, which may be sufficient given the historical pattern of peak flows lasting only a few days or less.

There is a potential for very high flows to be generated during large rain or rain on snow events in the West Fork Milo Creek Drainage Basin (see Table 2-2). The Guy Cave Area lies within this basin. Very high flows could drain over the surface area of the caves, and some portion of this flow will infiltrate to the mine. There is the potential that this could result in much higher flows than anticipated based on the return interval calculations, because they are based on historical flows. There is similar risk from the near-surface workings at the Small Hopes Drift area in Mainstem Milo Creek, and the Inez Shaft area of Deadwood Creek. The existing diversion systems in the mine may have insufficient capacity to divert very high flows into the mine pool. The AMD collection system at the Kellogg Tunnel portal has a capacity of 7,000 gpm, but it is unlikely that this much water would be captured because the Kellogg Tunnel ditch at the portal to which the collection system is tied has far less capacity.

Annual average metal loading to Bunker Creek from the upgraded CTP under Alternative 2 equals approximately <5 lb/yr for cadmium, <7 lb/yr for lead, and <460 lb/yr for zinc, based on an average annual flow of 1,500 gpm and effluent concentrations of <0.7μg/L cadmium, <1.0 μg/L lead, and <70 μg/L zinc. These amounts are significantly lower than current conditions.

Sludge production would be significantly less under Alternative 2 than under present conditions. The estimated current average annual accumulation rate in the CIA sludge disposal pond is 15,000 to 18,000 cubic yards. The average annual sludge accumulation rate for the onsite disposal options (options 2A, 2C, and 2D) is estimated to be 5,400 cubic yards. The average annual production rate for the offsite option (Option 2B) is estimated to be somewhat higher at about 10,300 cubic yards, because the sludge is not expected to dewater to the same extent in the mechanical equipment compared to sludge drying or disposal beds. For all sludge options, any water draining from the sludge as it is dewatered (filtrate) would be collected and re-treated.

Adequacy of Reliability and Controls. The upgraded CTP will include a backup diesel-driven electrical generator, two lime feeding systems, and other upgrades intended to reduce the risk of a failure that would shut down the plant unexpectedly. Land use restrictions would be needed to assure the viability of containing the treatment sludge and preventing dissolution. The existing in-mine diversion system uses pumps to draw mine water out of the ditches and to send it into the mine pool for temporary storage. The mine does not have backup power, so these pumps will not operate in a power outage. It is also possible that their capacity could be exceeded, as discussed earlier.

5.2.2.5 Reduction of Toxicity, Mobility, or Volume Through Treatment

Treatment Process and Remedy. The upgraded CTP lime neutralization treatment process will be operated in the HDS mode. This will provide a discharge having the effluent concentrations described above, but will also produce about one-half to one-third the sludge after dewatering compared to the existing LDS mode of operation.

Amount of Hazardous Material Destroyed or Treated. The upgraded CTP will remove more cadmium, lead, and zinc than the existing facility. The upgraded plant will remove all of the acidity, and over 99.9 percent of the cadmium, lead, and zinc.

Reduction of Toxicity, Mobility, or Volume. Similar to the existing CTP, in the upgraded CTP the mobility of the metals is substantially reduced by the treatment process. The metals are dissolved in the mine water at low pH conditions. In the dissolved form, the metals have the greatest toxicity and mobility. The precipitated metals are immobilized in the sludge under alkaline conditions and removed from contact with water, people, and wildlife, thus reducing or removing the toxicity from the environment.

The mobility of the metals is reduced by the treatment process. The precipitated metals remain immobilized as long as the sludge stays sufficiently alkaline to prevent dissolution and subsequent metal release. This potential will be minimized by either placing the sludge in engineered onsite disposal facilities (Options A, C, and D), or hauled offsite to an appropriate disposal facility (Option B). The filtrate from sludge dewatering would be collected and returned for treatment. The volume of sludge will be reduced to about one-half to one-third of the existing production rate.

Irreversibility of the Treatment. The treatment process is reversible. Metals in the sludge will have the potential to leach back into solution if contacted with sufficient acidity or be recoverable by future resource recovery methods. Thus, the sludge must be disposed in an appropriate facility to reduce the threat to the environment. If properly disposed and managed, the risk of metal release to the environment is expected to be minor. Treatment is considered fully reversible in the sense that other source control, resource recovery, or mining activities could be instituted in the future.

Type and Quantity of Treatment Residual. The treatment residual of concern is the sludge, which is estimated to accumulate at between about 5,400 (options 2A, 2C, and 2D) and 10,300 (Option 2B) cubic yards per year.

5.2.2.6 Short-Term Effectiveness

Protection of the Community During Remedial Actions. The major remedial construction activities for Alternative 2 are as follows:

- Construct the new segment of pipeline to allow direct feed of AMD to the CTP
- Upgrade the CTP to 5,000 gpm capacity for TMDL achievement
- Either construct new onsite sludge disposal beds, or haul dewatered sludge off site.

These activities are typical of industrial construction activities. All work will be done in existing industrial areas and areas already remediated through prior site cleanup actions. All work can be done in a manner protective of the community if appropriate construction practices are followed.

Protection of Workers During Remedial Actions. Workers will be exposed to normal construction-related risks. Following safe construction and best management practices can minimize the risks.

Environmental Impacts Associated with Construction. Environmental impacts associated with construction are expected to be minor. The land has been disturbed by prior development. Stream crossings will be needed for the new pipeline section and potentially for a sludge filtrate pipeline.

Time Until Remedial Response Objectives are Achieved. Alternative 2 is expected to meet the TMDL-based discharge levels and to be in compliance with most Idaho surface water quality criteria as soon as the CTP is upgraded and begins steady-state operation. A monitoring period of a few months may be needed to determine if other changes are needed in order to be in compliance with temperature, pH, dissolved oxygen, mercury, selenium, and thallium criteria. The HDS process will also reduce sludge production as soon as the upgraded plant is started up.

5.2.2.7 Implementability

Ability to Construct and Implement Technology. There are no barriers for construction and implementation of this alternative. All necessary technologies are standard and have been used at other sites. In-mine AMD collection, storage, and monitoring requires the cooperation of the New Bunker Hill Mining Company.

Reliability of Technology. All of the technologies required for this alternative exist and are well-understood and reliable, given proper operation and maintenance. The upgraded CTP will have backup power and redundant capabilities. This will increase reliability compared to the existing plant, and will reduce the risk of future release of partially treated or untreated AMD to the environment.

Ease of Undertaking Additional Remedial Actions, If Necessary. Implementation of Alternative 2 should not provide a serious impediment to other remedial actions, if necessary. Treatment is compatible with other source control and resource recovery options.

Ability to Monitor Effectiveness of Remedy. The monitoring will be the same as that currently done, consisting of continuous flow and periodic sampling at the Kellogg Tunnel portal, and continuous flow and daily sampling at the CTP. These monitoring activities will determine how well the remedy complies with the discharge requirements, and how much and what strength of AMD discharges from the mine. Kellogg Tunnel portal monitoring requires the cooperation of the New Bunker Hill Mining Company.

Coordination with Other Agencies. Administrative implementability for all work associated with this alternative should be straightforward and consistent with past Bunker Hill site agency coordination.

Availability of Treatment, Storage Capacity, and Disposal Services. Space is available at the CTP for the new equipment as described in Appendix E. Sufficient space is available within the mine for contingency AMD storage, although the existing diversion system is limited to about 1,050 gpm. The lined pond has about 7 million gallons of capacity, although currently it holds about 2 million gallons of muck, which is expected to be removed and placed in the

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existing sludge disposal bed on the CIA. There is sufficient space on site for 30 years of sludge disposal . There is sufficient regionally available offsite disposal capacity if the dewatered sludge is hauled off site.

Availability of Necessary Equipment and Specialists. The materials and workforce to implement this alternative are readily available. The work force is available locally or regionally.

Availability of Prospective Technologies. All technologies required for this alternative have been used before and are readily available.

5.2.2.8 Cost

Table 5-3 summarizes the order-of-magnitude (+50 to –30 percent) cost estimates for this alternative. The costs are summarized by remedy component. Total 30-year net present value costs at a 7 percent interest rate are shown, including total alternative costs using each sludge option. Additional cost detail is included in Appendix G.

5.2.3 Alternative 3—Phased Mitigations/Treatment

5.2.3.1 Description

Alternative 3 would phase the implementation of mitigations and treatment plant capacity based on monitoring results. An initial set of mitigations would be implemented and an initial CTP capacity (2,500 gpm) would be constructed. Up to 10 years of performance monitoring would be reviewed to determine if the initial mitigations and treatment plant capacity were sufficient, or if more were needed. A decision process consisting of data analysis, conceptual model refinement, assessment of mitigation effectiveness, and a cost/benefit analysis would be used to evaluate remedy performance, and to select subsequent actions if warranted. The cost estimate for Alternative 3 does not include subsequent CTP modifications or mitigations that may be needed after the performance evaluation period.

The following are the initial set of mitigations:

- West Fork Milo Creek Stream Diversion
- Rehabilitation of the Phil Sheridan Diversion System
- Drill Hole Plugging

Mine water flows in excess of 2,500 gpm would be stored in the lined pond or in the mine. A new gravity diversion system and extraction pumps would be installed for in-mine storage. The AMD conveyance pipe would be modified to allow direct flow to the CTP. Sludge would be disposed using one of the four sludge options. The initial remedial construction activities for Alternative 3 are as follows:

- Construct the West Fork Milo Creek Diversion, rehabilitate the Phil Sheridan Diversion, and plug the drill holes.

- Construct the new segment of pipeline to allow direct feed of AMD to the CTP.

- Construct the gravity in-mine diversion systems and the new mine pool extraction system.

- Improve and update the CTP to an initial 2,500 gpm filtration and optimum operation capacity. The hydraulic throughput and neutralization capacity will initially be 5,000 gpm.
- Construct one of the onsite sludge disposal options (options A, C, or D) or the offsite option (Option B).

5.2.3.2 Overall Protection of Human Health and the Environment

Alternative 3 is expected to be protective of human health and the environment. The treatment plant will be configured for compliance with the Idaho water quality standards and achievement of TMDL levels, and will use the same processes, equipment types, and backup systems as the plant described in Alternative 2. The expected typical CTP effluent is the same as for Alternative 2. The mitigations in the West Fork Milo Creek Basin are expected to help protect the area from high infiltration events that lead to very high peak flows from the mine.

The treatment plant capacity of 2,500 gpm is expected to be sufficient for all Kellogg Tunnel flows except for infrequent high flows, particularly with the installation of the West Fork Milo Creek mitigations. These infrequent high flows would be stored in the lined pond or mine for later extraction and treatment. All sludge management options are expected to be protective in the same manner as described for Alternative 2. However, about 10 percent less sludge is expected from Alternative 3 compared to Alternative 2. Disturbance associated with construction of the AMD pipeline, treatment plant, and sludge facilities should be similar to typical construction activities. Construction of the mitigations in the West Fork Milo Creek Basin will have some impact on the creek and drainage basin, but the creek is ephemeral and only flows during spring snowmelt or heavy rains. The stream channel ends at the Guy Cave Area where the water infiltrates to the mine. The diversion will be constructed in the streambed above the Guy Cave Area. The diversion pipe will be laid either beneath the access road approaching from below, or through areas disturbed by previous mining activities. Rehabilitation of the Phil Sheridan Diversion system will have minimal impact because the affected areas have been previously disturbed by past mining activities.

5.2.3.3 Compliance with ARARs

Chemical-Specific ARARs. The Alternative 3 CTP effluent is expected to be similar to that described for Alternative 2. Based on the treatability testing results, the anticipated CTP effluent quality should meet most of the potentially applicable surface water requirements, as well as the TMDL discharge levels for the CTP. The TMDL has been identified as a TBC.

Location-Specific ARARs. Alternative 3 actions are not expected to influence archaeological and/or historic sites of significance, and will not involve construction activities that might degrade Bunker Creek. Some minor amount of ephemeral stream habitat will be disturbed in the West Fork Milo Creek Basin during diversion construction. No remedial actions would be implemented that might affect relevant floodplains or wetlands. The residual metal in the CTP discharge is expected to have negligible impact on species considered under the ESA, and is actually expected to dilute concentrations of cadmium, lead, and zinc in the SFCdA River. EPA is consulting with the USFWS on potential impacts to endangered or threatened species or their habitats.

Action-Specific ARARs. The construction work associated with the remedial activities is expected to be in compliance with action-specific ARARs.

5.2.3.4 Long-Term Effectiveness and Permanence

Magnitude of Residual Risk. Alternative 3 employs actions to reduce the quantity of mine water discharging from the Kellogg Tunnel. The West Fork Milo Creek Diversion is expected to capture and divert stream flow away from the Guy Cave Area, and thereby reduce infiltration through the Flood-Stanly Ore Body. The rehabilitated Phil Sheridan Diversion is expected to reduce peak flows from the west portion of the drainage that is not in the area of influence of the proposed West Fork Milo Creek stream diversion. It will also capture surface flow that exceeds the capacity of the West Fork Milo Creek diversion structure. If Kellogg Tunnel flows in excess of 2,500 gpm were to occur, the excess would be stored in the lined pond or in the mine for later extraction and treatment. The upgraded CTP will also have the capability to hydraulically pass and neutralize up to 5,000 gpm, although filtration capacity is only originally 2,500 gpm.

There is some risk of high mine inflow from stream erosion into near-surface workings at the Small Hopes Drift area in Mainstem Milo Creek, and the Inez Shaft area of Deadwood Creek. These areas will be monitored and addressed by subsequent actions if needed.

The concrete ditch outside the Kellogg Tunnel portal has a capacity of 7,000 gpm, but it is unlikely that this much water would be captured because the ditch in the tunnel has less capacity. Construction of the mitigations is expected to reduce the risk of flows occurring that are higher than the Kellogg Tunnel ditch capacity.

The annual average metal loading to Bunker Creek from the upgraded CTP is expected to be less than for Alternative 2 because of lower mine water flows resulting from the mitigations. The specific reduction is unknown, but is estimated at about 10 percent based on the model results described in Section 4.2.1. Lime consumption and sludge production would be less than for Alternative 2 because of the reduction in AMD discharge collected for treatment. The 10 percent reduction is for implementation of the mitigations built during the initial phase (for Alternatives 3 and 4). Phased implementation of more mitigations may increase this. A maximum of 20 percent is estimated if all mitigations were implemented (for Alternative 5), as described in Section 4.2.1.

Construction of the mitigations, particularly those that reduce peak flows through the Flood-Stanly Ore Body, will reduce the size and frequency of high mine flows that flush accumulated acid salts. There is potential that infrequent flushing could result in accumulation of more salts than observed to date. If this occurred and a flushing event did happen, the resulting mine water could be worse quality than observed to date. However, the likelihood of this occurring is expected to be low (see Appendix B), and the residual risk can be minimized by periodic inspection in accessible areas for salt buildup, and by monitoring of in-mine AMD flows and chemistry. The specific effectiveness of the mitigations will not be known until they are constructed and operated for some time.

Adequacy of Reliability and Controls. The upgraded CTP will have similar backup and redundant systems as described for Alternative 2. The new gravity in-mine diversion system will have more capacity and will not rely on pumps. The mitigations will operate passively and are expected to require no active operation other than periodic inspection and clean-out.

5.2.3.5 Reduction of Toxicity, Mobility, or Volume Through Treatment

Treatment Process and Remedy. The upgraded CTP lime neutralization treatment process will be operated in the HDS mode similar to Alternative 2. This is expected to provide the same effluent concentrations. About 10 percent less sludge is expected because of less mine water needing to be treated because of the inflow reduction resulting from the mitigations.

Amount of Hazardous Material Destroyed or Treated. The mitigations are expected to reduce the total average annual water volume requiring collection and treatment by about 10 percent. The total amount of residual metals being discharged after treatment is expected to decrease by about 10 percent compared to Alternative 2.

Reduction of Toxicity, Mobility, or Volume. Alternative 3 is expected to reduce the volumes of mine water and sludge by about 10 percent compared to Alternative 2. Alternative 3 is expected to reduce the toxicity and mobility of the metals similarly to Alternative 2.

Irreversibility of the Treatment. As in Alternative 2, the treatment process will be reversible and the metals may be recoverable by future resource recovery methods. Metals in the sludge will have the potential to leach back into solution if exposed to acidic conditions; thus, the sludge must be disposed in an appropriate facility to reduce the threat to the environment. If properly disposed and managed, the risk of metal release to the environment is expected to be minor. Treatment is considered fully reversible in the sense that other source control, resource recovery, or mining activities could be instituted in the future.

Type and Quantity of Treatment Residual. The treatment residual of concern is the sludge, which is estimated to be about 10 percent less than Alternative 2.

5.2.3.6 Short-Term Effectiveness

Protection of the Community During Remedial Actions. All the construction activities use standard construction techniques and practices.

Protection of Workers During Remedial Actions. Workers will be exposed to normal construction-related risks. Following safe construction and best management practices can minimize the risks.

Environmental Impacts Associated with Construction. Construction impacts are expected to be minor. A section of the ephemeral West Fork Milo Creek will be affected by the mitigation work. The land in the other areas has been previously disturbed by prior development or mining activities. Stream crossings will be needed for the new pipeline section and possibly for filtrate from onsite sludge disposal facilities. The environmental impacts of these crossings can be reduced by minimizing work within the streambed.

Time Until Remedial Response Objectives are Achieved. Alternative 3 is expected to meet the TMDL-based discharge levels and to be in compliance with most Idaho surface water quality criteria as soon as the CTP is upgraded and begins steady-state operation. A monitoring period of a few months may be needed to determine if other changes are needed, to be in compliance with temperature, pH, dissolved oxygen, mercury, selenium, and thallium. The HDS process will also reduce sludge production as soon as the upgraded plant is started up.

The ultimate effectiveness of the mitigations will not be known until they are constructed, operated, and monitored for some time. A performance-monitoring and evaluation period of up to 10 years will take place following completion of the initial remedial actions. If additional actions are needed, they may consist of more mitigations, more treatment capacity, or both.

5.2.3.7 Implementability

Ability to Construct and Implement Technology. There are no barriers for construction and implementation of this alternative. All necessary technologies are standard and have been used at other sites. Some of the mitigation work will be on private land, such as the West Fork Milo Creek diversion structure and pipeline. Thus, access will need to be obtained. In-mine AMD collection, storage, and monitoring requires access from and coordination with the New Bunker Hill Mining Company.

Reliability of Technology. All required technologies exist, are well understood, and are reliable given proper operation and maintenance. The upgraded CTP will have backup power and redundant capabilities. These will increase the reliability compared to the existing plant, and will reduce the chance for release of partially treated or untreated AMD to Bunker Creek. All technologies required for the mitigations and other remedy components are standard technologies expected to be reliable.

Ease of Undertaking Additional Remedial Actions, If Necessary. Implementation of Alternative 3 should not provide a serious impediment to other remedial actions that may be necessary. Treatment is compatible with other source control and resource recovery options.

Ability to Monitor Effectiveness of Remedy. Monitoring is a key component of this alternative because the decision to implement more actions will be phased based on monitoring and performance evaluation as described in Section 4.3.3.7. This type of monitoring has been performed in the past. In-mine and Kellogg Tunnel portal monitoring requires the cooperation of the New Bunker Hill Mining Company. For the cost estimate it is assumed that surface and in-mine monitoring for performance assessment would be conducted for 10 years, then stopped. This should be sufficiently long enough to assess remedy performance and to implement and monitor any additional remedial measures.

Coordination with Other Agencies. Administrative implementability for all work associated with this alternative should be straightforward and consistent with past Bunker Hill site agency coordination.

Availability of Treatment, Storage Capacity, and Disposal Services. The required treatment, storage capacity, and disposal services are available. Space is available at the CTP for the

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required upgrades. Sufficient space is available within the mine for AMD storage. There is sufficient space on- or offsite for 30 years of sludge disposal.

Availability of Necessary Equipment and Specialists. The materials and workforce to implement this alternative are readily available. The work force is available locally or regionally.

Availability of Prospective Technologies. All technologies required for this alternative have been used before and are readily available.

5.2.3.8 Cost

Table 5-4 summarizes the order-of-magnitude (+50 to –30 percent) cost estimate for Alternative 3. The costs are summarized by remedy component. The total alternative net present value using each sludge management option is summarized at the bottom of the table. The cost estimate includes a 10 percent lime and sludge reduction expected from the mitigations. The cost estimate does not include subsequent CTP modifications or mitigations that may be needed after the performance evaluation period. Additional cost detail is included in Appendix G.

5.2.4 Alternative 4—Phased Mitigations/Treatment with Plugging of Near-Stream Workings

5.2.4.1 Description

All components of Alternative 4 are the same as Alternative 3 except it includes two more initial mitigations. These are plugging the Small Hopes drift below Mainstem Milo Creek, and plugging the Inez Shaft below Deadwood Creek. This would reduce or eliminate the possibility of high stream flows eroding direct flow paths into the mine through these areas. Alternative 4 uses the same type of phased approach as Alternative 3 for monitoring performance and determining the need for additional actions.

The initial remedial construction activities for Alternative 4 are as follows:

- Construct the West Fork Milo Creek Diversion, rehabilitate the Phil Sheridan Diversion, plug the drill holes, plug the Small Hopes Drift below Mainstem Milo Creek, and plug the Inez Shaft below Deadwood Creek.
- Construct the new segment of pipeline to allow direct feed of AMD to the CTP.
- Construct the gravity in-mine diversion systems and the new mine pool extraction system.
- Improve and update the CTP to an initial 2,500 gpm optimum operation and filtration capacity. The hydraulic throughput and neutralization capacity will initially be 5,000 gpm.
- Construct one of the four sludge management options.

5.2.4.2 Overall Protection of Human Health and the Environment

Alternative 4 is expected to be protective of human health and the environment. The protection provided is expected to be somewhat greater than for Alternative 3 because of a smaller likelihood of high mine water flows resulting from erosion into workings below Mainstem Milo Creek and Deadwood Creek.

Historically, the Inez Shaft was a location where direct stream inflow could occur. The shaft was constructed in the bottom of Deadwood Creek. Over the years the shaft has become covered by stream-deposited alluvial material. The concern is that this material could be scoured out during high creek flows. A similar situation exists in Milo Creek for the Small Hopes drift. If direct inflow were to occur, the mine water flow may be too high to store or treat, resulting in untreated AMD entering Bunker Creek. Currently there is no indication of appreciable inflow through these areas, based on 1998/1999 in-mine monitoring data. Therefore, the average annual volume of mine water requiring treatment is expected to be similar to Alternative 3.

5.2.4.3 Compliance with ARARs

Chemical-Specific ARARs. Compliance with chemical-specific ARARs is expected to be the same as for Alternative 3. Attainment of the TMDL, a TBC, is also expected to be the same as for Alternative 3.

Location-Specific ARARs. The only difference compared to Alternative 3 will be the construction work associated with the Inez Shaft area in Deadwood Creek and the Small Hopes drift area in Mainstem Milo Creek, where some stream impacts will occur. Both of these areas have been previously disturbed by past mining activities. No remedial actions will be implemented that might affect relevant floodplains or wetlands. The residual metal in the CTP discharge is expected to have negligible impact on species considered under the ESA, and is actually expected to dilute concentrations of cadmium, lead, and zinc in the SFCdA River. EPA is consulting with the USFWS on potential impacts to endangered or threatened species or their habitats.

Action-Specific ARARs. The construction work associated with the remedial activities is expected to be in compliance with action-specific ARARs.

5.2.4.4 Long-Term Effectiveness and Permanence

Magnitude of Residual Risk. Alternative 4 employs actions to reduce the quantity of mine water emanating from the mine, and to protect from erosional flow paths into known near-stream workings. This will initially reduce the residual risk compared to Alternative 3, although, under Alternative 3, the workings could be plugged later if monitoring data suggest it is needed. The specific effectiveness of the mitigations will not be known until they are constructed and operated for some time.

The annual average metal loading to Bunker Creek from the upgraded CTP is expected to be the same as for Alternative 3. The average annual lime consumption and sludge production is also expected to be the same.

Adequacy of Reliability and Controls. The adequacy of reliability and controls is expected to be similar to Alternative 3. The plugs installed in the near-stream workings are expected to require minimal inspection and maintenance.

5.2.4.5 Reduction of Toxicity, Mobility, or Volume Through Treatment

Treatment Process and Remedy. The upgraded CTP lime neutralization treatment process will be operated in the HDS mode similar to Alternatives 2 and 3. This is expected to provide the same effluent concentrations. The average annual lime consumption and sludge production is expected to be the same as for Alternative 3.

Amount of Hazardous Material Destroyed or Treated. The mitigations are expected to reduce the total average annual water volume requiring collection and treatment to about the same extent as Alternative 3. This is a reduction of about 10 percent compared to Alternatives 1 and 2.

Reduction of Toxicity, Mobility, or Volume. Alternative 4 is expected to reduce the volumes of mine water, CTP effluent metals, and sludge to the same amounts as for Alternative 3. Alternative 4 is expected to reduce the toxicity and mobility of the metals similar to Alternatives 2 and 3.

Irreversibility of the Treatment. As in Alternatives 1, 2, and 3, the treatment process will be reversible. Metals in the sludge will have the potential to leach back into solution if exposed to acidic conditions. Thus, the sludge must be disposed in an appropriate facility to reduce the threat to the environment. If the sludge is properly disposed and managed, the risk of metal release to the environment is expected to be minor. Treatment is considered fully reversible in the sense that other source control, resource recovery, or mining activities could be instituted in the future.

Type and Quantity of Treatment Residual. The treatment residual of concern is the sludge, which is estimated to be the same amount as for Alternative 3, and about 10 percent less than Alternative 2.

5.2.4.6 Short-Term Effectiveness

Protection of the Community During Remedial Actions. All the construction activities use standard construction techniques and practices. These activities are expected to be performed in a protective manner.

Protection of Workers During Remedial Actions. Workers will be exposed to normal construction-related risks. Following safe construction and best management practices can minimize the risks.

Environmental Impacts Associated with Construction. Construction impacts are expected to be minor. A section of the ephemeral West Fork Milo Creek will be affected by the diversion. The land in the other areas has been previously disturbed by prior development or mining activities. Stream crossings will be needed for the new pipeline section and possibly for sludge filtrate. The environmental impacts of these crossings are expected to be minor. Construction of the plugs will require temporary diversion of Milo Creek and Deadwood Creek flows around the work areas. The work will be done during the low flow period of the year. Milo Creek is already diverted above the plug location at Small Hopes, but there may be residual flows or groundwater. Deadwood Creek is already disturbed at the Inez Shaft area from past mining activities, but additional disturbance will be necessary to mobilize equipment and materials in this area.

Time Until Remedial Response Objectives are Achieved. Alternative 4 is expected to meet the TMDL-based discharge levels and to be in compliance with most Idaho surface water quality criteria as soon as the CTP is upgraded and begins steady-state operation. A monitoring period of a few months may be needed to determine if other changes are needed, to be in compliance with temperature, pH, dissolved oxygen, mercury, selenium, and thallium. The HDS process will also reduce sludge production as soon as the upgraded plant is started up. The specific effectiveness of the mitigations will not be known until they are constructed, operated, and monitored for some time. A performance-monitoring and evaluation period of up to 10 years will take place following completion of the initial remedial actions. If additional actions are needed, they may consist of more mitigations, more treatment capacity, or both.

5.2.4.7 Implementability

Ability to Construct and Implement Technology. There are no barriers for construction and implementation of this alternative. All necessary technologies are standard and have been used at other sites. Access will be required for the remedial work on private land. In-mine AMD collection, storage, and monitoring requires access from and coordination with the New Bunker Hill Mining Company.

Reliability of Technology. All technologies required for this alternative are fully developed, are well understood, and are reliable given proper operation and maintenance. The upgraded CTP will have backup power and redundant capabilities. These will increase the reliability compared to the existing plant and will reduce the chance for release of partially treated or untreated AMD to Bunker Creek. All technologies required for the mitigations and other remedy components are standard technologies expected to be reliable.

Ease of Undertaking Additional Remedial Actions, If Necessary. Implementation of Alternative 4 should not provide a serious impediment to other remedial actions that may be necessary. Treatment is compatible with other source control and resource recovery options.

Ability to Monitor Effectiveness of Remedy. Monitoring is a key component of this alternative because the decision to implement more actions will be phased based on monitoring and performance evaluation as described in Section 4.3.3.7. This type of monitoring has been performed in the past. In-mine and Kellogg Tunnel portal monitoring requires the cooperation of the New Bunker Hill Mining Company. For the cost estimate it is assumed that surface and in-mine monitoring for performance assessment would be conducted for 10 years, then stopped. This should be sufficiently long enough to assess remedy performance and to implement and monitor any additional remedial measures.

Coordination with Other Agencies. Administrative implementability for all work associated with this alternative should be straightforward and consistent with past Bunker Hill site agency coordination.

Availability of Treatment, Storage Capacity, and Disposal Services. The required treatment, storage capacity, and disposal services are available. Space is available at the CTP for the

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required upgrades. Sufficient space is available within the mine for AMD storage. There is sufficient space on- or offsite for 30 years of sludge disposal.

Availability of Necessary Equipment and Specialists. The materials and workforce to implement this alternative are readily available. The work force is available locally or regionally.

Availability of Prospective Technologies. All technologies required for this alternative have been used before and are readily available.

5.2.4.8 Cost

Table 5-5 summarizes the order-of-magnitude (+50 to –30 percent) cost estimate for Alternative 4. The costs are summarized by remedy component. The total alternative net present value using each sludge management option is summarized at the bottom of the table. The cost estimate includes a 10 percent lime and sludge reduction expected from the mitigations. The cost estimate does not include subsequent CTP modifications or mitigations that may be needed after the performance evaluation period. Additional cost detail is included in Appendix G.

5.2.5 Alternative 5—Treatment with All Mitigations

5.2.5.1 Description

Alternative 5 does not use a phased approach. It consists of initial implementation of all the mitigations and construction of 2,500 gpm of upgraded treatment plant capacity. Mitigation performance monitoring is conducted for the first 5 years, but not after because no subsequent mitigations would be considered for phased implementation.

The remedial construction activities for Alternative 5 are as follows:

- Construct the West Fork Milo Creek Diversion, rehabilitate the Phil Sheridan Diversion, plug the drill holes, plug the Small Hopes Drift below Milo Creek, plug the Inez Shaft below Deadwood Creek, construct the sidehill diversion in West Fork Milo Basin, construct the South Fork Milo Creek Diversion, bypass the Bunker Hill Dam in Mainstem Milo Creek, improve the existing diversion in Mainstem Milo Creek, and upgrade the Phil Sheridan raise system in West Fork Milo Basin.
- Construct the new segment of pipeline to allow direct feed of AMD to the CTP.
- Construct the gravity in-mine diversion systems and the new mine pool extraction system.
- Improve and update the CTP to a 2,500 gpm optimum operation and filtration capacity. The hydraulic throughout and neutralization capacity will be 5,000 gpm.
- Construct one of the four sludge management options.

5.2.5.2 Overall Protection of Human Health and the Environment

Alternative 5 is expected to be protective of human health and the environment. The overall protection provided is expected to be somewhat less than Alternatives 3 and 4 due to the lack of a phased approach. The phased approach provides greater flexibility to use or benefit from new information gained during the installation and operation of initial mitigations, treatment plant capacity, or both. The average annual volume of mine water requiring treatment is estimated to be about 20 percent less than for Alternatives 1 and 2, and about 10 percent less than for Alternatives 3 and 4 as initially implemented.

5.2.5.3 Compliance with ARARs

Chemical-Specific ARARs. Compliance with chemical-specific ARARs and attainment of TBCs is expected to be the same as for Alternatives 2, 3, and 4. Based on the treatability testing results, the anticipated CTP effluent quality should meet most of the potentially applicable surface water requirements, as well as the TMDL discharge levels for the CTP. The TMDL has been identified as a TBC.

Location-Specific ARARs. Alternative 5 actions are not expected to influence archaeological and/or historic sites of significance, and will not involve construction activities that might degrade Bunker Creek. Some minor amount of ephemeral stream habitat will be disturbed in the West Fork Milo Creek Basin, the South Fork Milo Creek Basin, Mainstem Milo Creek, and in Deadwood Creek Basin as a result of mitigation construction. No remedial actions would be implemented that might affect relevant floodplains or wetlands. The residual metal in the CTP discharge is expected to have negligible impact on species considered under the ESA, and is actually expected to dilute concentrations of cadmium, lead, and zinc in the SFCdA River. EPA is consulting with the USFWS on potential impacts to endangered or threatened species or their habitats.

Action-Specific ARARs. The construction work associated with the remedial activities is expected to be in compliance with action-specific ARARs.

5.2.5.4 Long-Term Effectiveness and Permanence

Magnitude of Residual Risk. Alternative 5 employs actions to reduce the quantity of mine water emanating from the mine, and to protect from erosion of flow paths into known near-stream workings. This will reduce the residual risk. Initial implementation of all mitigations will reduce the risk of mine water flows in excess of treatment plant capacity. The specific effectiveness of the mitigations will not be known until they are constructed and operated for some time. It is possible that the additional mitigations may not substantially increase the overall remedy effectiveness compared to Alternatives 3 and 4. This depends on their effectiveness, which is currently unknown.

The annual average metal loading to Bunker Creek from the upgraded CTP is expected to be about 20 percent less than for Alternative 2, and about 10 percent less than for Alternatives 3 and 4 as initially implemented (additional mitigations implemented for Alternatives 3 and 4 as part of the phased approach may reduce residual metal load to the creek). Sludge production is also expected to be 20 percent less than Alternative 2, and 10 percent less than Alternatives 3 and 4 as initially implemented.

Adequacy of Reliability and Controls. The adequacy of reliability and controls is expected to be similar to Alternatives 3 and 4. The additional mitigations will require inspection and maintenance.

5.2.5.5 Reduction of Toxicity, Mobility, or Volume Through Treatment

Treatment Process and Remedy. The upgraded CTP lime neutralization treatment process will be operated in the high-density sludge mode similar to Alternatives 2, 3, and 4. This is expected to provide the same effluent concentrations.

Amount of Hazardous Material Destroyed or Treated. The mitigations are expected to reduce the total average annual AMD volume requiring collection and treatment by about 20 percent. About the same percentages of metal will be removed as for Alternatives 2, 3, and 4 because the treatment plants are expected to have the same effluent concentrations.

Reduction of Toxicity, Mobility, or Volume. Alternative 5 is expected to initially reduce the volumes of mine water, CTP effluent metals, and sludge more than any of the other alternatives. The reductions are expected to be 20 percent more than for Alternative 2, and 10 percent more than for Alternatives 3 and 4 as initially implemented (additional mitigations could be constructed as part of their phased approach).

Irreversibility of the Treatment. As in all other alternatives, the treatment process will be reversible. Metals in the sludge will have the potential to leach back into solution if exposed to acidic conditions. Thus, the sludge must be disposed in an appropriate facility to reduce the threat to the environment. If the sludge is properly disposed and managed, the risk of metal release to the environment is expected to be minor. Treatment is considered fully reversible in the sense that other source control, resource recovery, or mining activities could be instituted in the future.

Type and Quantity of Treatment Residual. The treatment residual of concern is the sludge, which is estimated to be about 20 percent less than for Alternative 2, and about 10 percent less than for Alternatives 3 and 4 as initially implemented.

5.2.5.6 Short-Term Effectiveness

Protection of the Community During Remedial Actions. All the construction activities use standard construction techniques and practices. These activities are expected to be performed in a protective manner.

Protection of Workers During Remedial Actions. Workers will be exposed to normal construction-related risks. Following safe construction and best management practices can minimize the risks.

Environmental Impacts Associated with Construction. Construction impacts are expected to be minor. A section of the ephemeral West Fork Milo Creek and a section of South Fork Milo Creek will be affected by the diversions. The land in the other areas has been previously disturbed by prior development or mining activities. Stream crossings will be needed for the new pipeline section and possibly for sludge filtrate. The environmental impacts of these crossings are expected to be minor. Construction of the plugs will require temporary diversion of Milo Creek and Deadwood Creek flows around the work areas.

Time Until Remedial Response Objectives Are Achieved. Alternative 5 is expected to meet the TMDL-based discharge levels and to be in compliance with most Idaho surface water quality criteria as soon as the CTP is upgraded and begins steady-state operation. A monitoring period of a few months may be needed to determine if other changes are needed to be in compliance with temperature, pH, dissolved oxygen, mercury, selenium, and thallium. The HDS process will also reduce sludge production as soon as the upgraded plant is started up.

5.2.5.7 Implementability

Ability to Construct and Implement Technology. There are no barriers for construction and implementation of this alternative. All necessary technologies are standard and have been used at other sites. Some of the mitigation remedial work in Milo Basin will be on private land. In-mine AMD collection, storage and monitoring requires access from and coordination with the New Bunker Hill Mining Company.

Reliability of Technology. All of the technologies required for this alternative are fully developed, are well understood, and are reliable given proper operation and maintenance. The upgraded CTP will have backup power and redundant capabilities as described in Section 3.6. Compared to the existing plant, the improvements will increase plant reliability and will reduce the chance that partially treated or untreated AMD will be released into Bunker Creek.

Ease of Undertaking Additional Remedial Actions, If Necessary. No subsequent mitigation or treatment plant upgrades are considered for Alternative 5. However, implementation of Alternative 5 should not provide a serious impediment to other remedial actions if necessary. Treatment is compatible with other source control and resource recovery options.

Ability to Monitor Effectiveness of Remedy. Monitoring will be conducted to assess mitigation effectiveness and to monitor for buildup of acid salts within the mine. This is assumed to continue for 5 years after construction. Monitoring will be similar to that described for Alternatives 3 and 4. Treatment plant performance will be tracked by continual flow monitoring and daily sampling. All of this monitoring has been performed in the past. In-mine and Kellogg Tunnel portal monitoring requires the cooperation of the New Bunker Hill Mining Company.

Coordination with Other Agencies. Administrative implementability for all work associated with this alternative should be straightforward and consistent with past Bunker Hill site agency coordination.

Availability of Treatment, Storage Capacity, and Disposal Services. The required treatment, storage capacity, and disposal services are available. Space is available at the CTP for the required upgrades. Sufficient space is available within the mine for AMD storage. There is sufficient space on- or off-site for 30 years of sludge disposal.

Availability of Necessary Equipment and Specialists. The materials and workforce to implement this alternative are readily available. The work force is available locally or regionally.

Availability of Prospective Technologies. All technologies required for this alternative have been used before and are readily available.

5.2.5.8 Cost

Table 5-6 summarizes the order-of-magnitude (+50 to –30 percent) cost estimate for Alternative 5. The costs are summarized by remedy component. The total alternative net present value using each sludge management option is summarized at the bottom of the table. The cost estimate includes a 20 percent lime and sludge reduction expected from the mitigations. Additional cost detail is included in Appendix G.

5.3 Comparative Analysis

This concluding section of the Bunker Hill Mine Water Remedial Investigation and Feasibility Study report presents a comparison of the alternatives. The preceding text profiled each alternative against the two threshold criteria and five balancing criteria. This section shifts the focus to the individual criteria and provides a succinct comparison of the advantages and disadvantages for the benefit of stakeholders and decisionmakers. Table 5-7 provides a summary.

5.3.1 Summary Descriptions

The main elements of the alternatives are summarized in Table 4-4. Table 5-8 highlights the major differences.

5.3.2 Overall Protection of Human Health and the Environment

Alternative 1 does not protect human health and the environment. It results in the direct discharge of untreated AMD to Bunker Creek that endangers humans and results in toxic conditions for aquatic life. Alternatives 2 through 5 all use the same treatment technology. They protect human health and the environment by removing the toxicity associated with AMD to levels that achieve the TMDL discharge allocations for the CTP. Alternatives 3, 4, and 5, however, provide some additional protectiveness over Alternative 2. They include mitigations to reduce the overall volume of AMD, and upgraded diversion and pumping systems that permit more significant in-mine water storage. These additional components reduce the chance of high mine water flows exceeding the downstream capacity of the treatment plant and resulting in a release of untreated AMD to Bunker Creek. Alternative 2, which uses a larger-capacity treatment plant, does not have these additional safeguards. Alternatives 3 and 4 are believed to be somewhat more protective than Alternative 5. They employ a phased approach to implementing mitigations and treatment plant sizing. This approach allows careful consideration of the most effective ways to either reduce mine water flow or optimize treatment plant size. Alternative 5 does not use a phased approach; thus, it has no built-in flexibility to use or benefit from new information gained during installation and operation of initial mitigations, treatment capacity, or both. This lack of flexibility reduces its ability to protect as compared to Alternatives 3 and 4.

All four sludge options are expected to be protective of the community and the environment. Options A, C, and D, the onsite sludge disposal options, provide protection by using lined disposal facilities to prevent leakage to the environment. Fencing and gates would also be used to prevent public exposure to sludge. Option A, disposal in sludge beds located on the CIA, may provide somewhat higher worker protection because sludge handling is minimized. Option B, offsite disposal, provides protection by removing the sludge from the community and transporting it to a secure facility.

5.3.3 Compliance with ARARs

Alternative 1 will not meet chemical-specific ARARs and results in release of untreated AMD to Bunker Creek. All other alternatives are expected to be in compliance with most Idaho surface water discharge criteria, and achieve the TMDL discharge levels for the CTP. Performance monitoring of the upgraded CTP is needed to further assess compliance for Idaho surface water criteria for mercury, selenium, thallium, temperature, dissolved oxygen, and pH. Alternatives 2, 3, 4 and 5 are expected to be in compliance with other chemical-, location-, and action-specific ARARs. All four sludge management options are expected to be in compliance with all ARARs. Therefore, there is no difference between Alternatives 2 through 5 for compliance with ARARs.

5.3.4 Long-Term Effectiveness and Permanence

None of the alternatives will halt the acid-producing reactions occurring within the mine. Acid production and metal release is expected to continue for hundreds or thousands of years unless new technology becomes available and is used to stop the process. The alternatives, however, differ in the degree to which they reduce the quantity of AMD and the magnitude of residual risk remaining from treatment plant sludge.

Alternative 1 takes no measures to reduce the long-term release of AMD from the mine and results in increased long-term human health risk and environmental harm by direct discharge of AMD to Bunker Creek. Alternative 2 also does not reduce the long-term release of AMD from the mine, but uses improved and larger treatment systems to protect human health and the environment. Alternatives 3, 4, and 5 use mitigations to reduce both peak and average AMD flows, which reduces the long-term risk from large flows exceeding treatment capacity compared to Alternative 2. These alternatives, therefore, provide the greatest degree of long-term effectiveness and permanence. The specific effectiveness of the mitigations will not be known until they are constructed and operated for some time; thus, it is possible that the additional mitigations initially implemented in Alternative 5 may not substantially increase overall remedy effectiveness compared to Alternatives 3 and 4.

Alternatives 2 through 5 all require long-term operation, maintenance, and periodic replacement of components. The mitigation facilities of Alternatives 3, 4, and 5 must be inspected and maintained. The mitigation facilities in the West Fork Milo Creek will be difficult to access and clean during winter and spring because of snow accumulation, which increases the probability of clogging by debris and the bypass of water into the mine. However, the potential for this occurring would be minimized during design. AMD collection within the mine is the same for all alternatives. Continual and substantial effort is needed to keep the workings maintained to ensure unimpeded movement of AMD either into storage or out through the Kellogg Tunnel. The in-mine gravity storage system used in Alternatives 3, 4, and 5 will be more reliable than the pumped system of Alternative 2. Alternatives 2 through 5 all use the same treatment processes, which are expected to provide long-term protection by reducing the acid and metals to safe levels. The treatment plants are expected to be reliable and have reasonable backup systems.

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Alternatives 2 through 5 all produce the same type of sludge. Compared to Alternative 2, Alternatives 3, 4, and 5 are expected to reduce long-term sludge volumes. These reductions reduce the volume of on- or offsite land required for long-term disposal, and the magnitude of residual risk remaining from the sludge. All four sludge management options are expected to have adequate and reliable controls to prevent migration of contaminants and public exposure, although Option B (offsite disposal) is expected to produce nearly twice the sludge volumes as the other options. Sufficient sludge disposal space is available onsite for Options A, C, and D, or regionally for Option B. Long-term land use restrictions will be needed for the onsite options (A, C, and D) to prevent disturbance of the capped and closed disposal areas. Option D will require about 300 to 600 truckloads of sludge to be hauled each fall along McKinley Avenue from the CIA drying beds to the smelter closure area landfill. Although the trucks would be decontaminated, this volume of truck traffic could be disruptive.

5.3.5 Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternative 1 results in the existing treatment plant shutting down in 3 to 5 years. This causes an increase in the toxicity, mobility, and volume of AMD contaminants compared to current conditions.

Alternatives 2 through 5 all use the same lime HDS treatment process to remove dissolved metals, and the same type of media filters for removal of suspended metals. The same treatment plant effluent quality is expected from each alternative. The treatment process will remove all of the acidity and will reduce cadmium, lead, and zinc to levels that attain the TMDLs. The process is expected to significantly reduce the toxicity, mobility, and volume of AMD contaminants by incorporating them into an alkaline sludge. The sludge is classified as a non-hazardous waste. It is expected to pass the TCLP test, and it is excluded from being characterized as a hazardous waste by the Bevill Amendment to RCRA. Alternative 2 however, does not employ source control measures that are expected to reduce the quantity of AMD generated and volume of sludge produced. Alternatives 3, 4, and 5 all employ such measures and thus provide greater volume reductions than Alternative 2. Alternatives 3 and 4 are expected to produce about 10 percent less AMD and sludge than Alternative 2 as initially implemented (greater reductions may be achieved if additional mitigations are constructed), and Alternative 5 is expected to produce 20 percent less AMD and sludge than Alternative 2.

The treatment process could be reversed if the alkaline sludge is dissolved by contact with sufficient acidity. The onsite options (A, C, and D) use low-permeability liner and cover systems to isolate the sludge from the environment and potential sources of acidity. Long-term land use restrictions are needed to prevent the covered and closed facilities from being disturbed. The offsite option will use appropriate disposal facilities to ensure that the sludge is properly managed.

5.3.6 Short-Term Effectiveness

Alternative 1 increases the risk posed by release of untreated AMD by halting maintenance of existing AMD management systems. Alternatives 2 through 5 are expected to provide about the same short-term protectiveness. The AMD will continue to be collected, stored, and treated using existing systems during construction of new systems. Impacts on the

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community during construction of Alternatives 2 through 5 are expected to be similar because they all involve AMD pipeline and CTP upgrades, and possibly sludge disposal onsite. Worker safety is also expected to be about the same because each uses similar construction practices.

Environmental impacts associated with Alternatives 3, 4, and 5 are greater than Alternative 2 because of impacts from mitigation construction. Some of the mitigations require work in stream segments, although some of the segments have been previously disturbed by past mining activities.

Alternatives 2 through 5 will provide protection as soon as they are implemented. The implementation time is similar for each. The phased approach used for Alternatives 3 and 4, may take up to 10 years to complete, but initially implemented remedial actions are expected to provide protection from untreated releases of AMD during the phasing period.

The onsite sludge options (A, C, and D) are expected to have about the same construction impacts on the community because they require similar construction methods and timeframes. Option B, the offsite option, will have minimal community construction impacts because all construction occurs at the CTP.

5.3.7 Implementability

Alternative 1, although technically feasible to implement, may have low administrative feasibility because of the resulting environmental consequences from untreated AMD entering Bunker Creek and the SFCdA River. Alternatives 2 through 5 all have similar implementability. All use standard technologies expected to be reliable given proper operation and maintenance, and all require materials and services available locally or regionally. None of the alternatives prevent the undertaking of additional remedial actions, if necessary. Alternatives 2 through 5 all have the same administrative feasibility, which requires agency coordination similar to that already conducted for other portions of the site. Alternatives 3, 4, and 5 require coordination with landowners to implement mitigations.

Alternatives 2 through 5 require coordination with the New Bunker Hill Mining Company to implement in-mine AMD collection, storage, and monitoring. Alternatives 3, 4, and 5 require in-mine monitoring to assess the effectiveness of the mitigations. In-mine monitoring is technically feasible and requires the cooperation of the New Bunker Hill Mining Company for access to underground monitoring locations. In-mine monitoring is not required for Alternative 2.

Onsite sludge options (A, C, and D) would be constructed on federally owned land and would use standard technologies. Therefore, there are no administrative impediments to locating sludge disposal beds in these areas. These areas are also currently under industrial use (waste containment/disposal) and they are anticipated to remain so in the future. There has been some community interest in reuse of the top of the CIA (such as for a golf course) once it has been capped. However, thus far there are no specific plans or agreements in place regarding what type of reuse may be appropriate. Option A, which would be located on top of the CIA, would not preclude community redevelopment of the CIA in the future because the sludge disposal beds would occupy only a limited portion of the CIA (about 10 percent over 30 years), and would be covered and capped when full. Option C will be more difficult to implement than options A and D because of the required sludge pump station and pipeline along McKinley Avenue. Reliance on the pump station and pipeline may make Option C less reliable than options A or D. There is sufficient regionally available offsite sludge disposal capacity for Option B.

5.3.8 Cost

5.3.8.1 Cost Comparison

Table 5-9 presents estimates of the 30-year net present value costs for the alternatives. Figure 5-1 provides a cost comparison, with the alternatives arranged from lowest to highest total cost using net present values. The 30-year basis is selected merely to compare the early costs of the alternatives. All of the alternatives, except Alternative 1, are expected to have costs beyond 30 years because present information shows that contaminated mine water flows are expected to continue beyond 30 years. Figure 5-2 shows a graphical comparison of cumulative non-discounted costs to cumulative discounted (net present value) costs for a 100-year period for all alternatives except Alternative 1. The figure illustrates the affects of discounting future costs to net present values using a 7 percent interest rate. The right side of Figure 5-2 lists the alternatives arranged from highest to lowest cost. Alternative 5B is the highest cost alternative, and Alternative 2A is the lowest cost alternative for both non-discounted and discounted scenarios. The 30-year net present value costs range from $6.4 million for Alternative 1 to $66.4 million for Alternative 5B. Alternatives 3 and 4 are in the middle of the cost range. Other than Alternative 1, Alternative 2 is the least costly, and Alternatives 3, 4, and 5, which all use mitigations, are more costly. Total costs generally go up as more mitigations are implemented. Annual O&M costs also go up as more mitigations are implemented.

Of the four sludge options, Option B, which uses mechanical dewatering and offsite disposal, is the most costly. Option A, which uses CIA sludge drying beds, is the least costly. Options C and D have about the same cost.

5.3.8.2 Cost Assumptions and Uncertainties

All the cost estimates are the product of “order-of-magnitude” estimating procedures based on conceptual layouts and preliminary cost information. Estimates of this nature are subject to significant changes as more detailed engineering and cost information becomes available. It is commonly assumed that actual costs may vary from the stated amounts by as much as plus 50 percent and minus 30 percent. The final remedial action costs will depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, final project scope, final schedule, and other variable factors. As a result, the final remedial action costs will vary from those presented in Table 5-9. Other assumptions and uncertainties that affect the alternative cost estimates are summarized below. Additional cost details and assumptions may be found in Appendix G.

- The discount rate used for net present value is 7 percent, and the analysis period is 30 years for each alternative. Although mine water management is expected to continue beyond 30 years, all alternatives contain remedial components sharing similar life cycles. Thus, a longer net present value period is not expected to accurately change the relative cost rank of the alternatives, nor provide more accurate cost assessments given the inherent uncertainties associated with the order-of-magnitude cost estimates, estimates of mitigation effectiveness, and long-term site, regulatory, social, and technological

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conditions. However, it is likely that total costs to manage the mine water forever will be higher than those presented in Table 5-9 (see Figure 5-2). In addition to 7 percent, cost estimates using discount rates of 3, 5, and 10 percent were developed during preparation of the draft RI/FS document. These estimates were not included in the final RI/FS because the different discount rates did not change the relative cost rank of the alternatives.

- Alternative 1 costs (the No Further Action alternative) assume that the CTP and other current mine water management-related control measures are continued for 4 years, then shut down. The 4-year duration is based on 3 to 5 years of remaining volume in the existing sludge disposal area. It is assumed that the CTP would be shut down when the sludge disposal volume is exhausted because the CTP cannot operate without sludge disposal. The actual CTP operational period may vary from the assumed 4-year period.
- The costs consider that the annual mine water volumes and chemistry stay similar to historical values, or are reduced by the mitigations. The actual costs will depend on actual volumes and chemistry.
- Alternatives 3, 4, and 5 include estimated cost savings resulting from mitigation-induced mine water flow reductions. Alternatives 3 and 4 include an assumed 10 percent reduction in lime consumption and sludge production, and Alternative 5 assumes 20 percent reductions. The actual cost savings will depend on the actual mine water flow reductions and the chemistry of the resulting mine water.
- Costs for additional mitigations or treatment plant capacity installed as part of the phased approach for Alternatives 3 and 4 are not included in the cost estimates.
- The 100-year cumulative costs illustrated in Figure 5-2 may not represent long-term future costs because of the assumptions needed to develop the figure. The costs assume replacement of mechanical equipment every 15 years, and no change in remedial technology or approach over the 100-year period.

TABLE 5-1
Cost Summary for Alternative 1—No Further Action
Bunker Hill Mine Water RI/FS Report

Remedy Component	Capital Cost ($)	Annual O&M Cost[1] ($/yr)	4-Year Net Present value[2] ($)
AMD Mitigations	0	0	0
AMD Collection	0	1,071,000	3,627,000
AMD Conveyance	0	93,000	315,000
AMD Storage	0	31,000	105,000
AMD Treatment	0	682,000	2,310,000
Sludge Management[3]	0	0	0
Performance Monitoring[3]	0	0	0
Alternative 1 Totals	0	1,877,000	6,358,000

[1]O&M costs are for only a 4-year period.
[2]Net present value is based on costs to operate the existing components for 4 years, at which point all remedial expenditures will cease. Interest rate for net present value is 7 percent.
[3]Sludge management and performance monitoring costs are included in the treatment costs.

TABLE 5-2
Comparison of Treatability Results to Potential State of Idaho Surface Water ARARs for Chemicals of Concern (µg/L)[1]
Bunker Hill Mine Water RI/FS Report

Chemical	Estimated Effluent Concentration[2]	Freshwater Aquatic Life Protection		Human Health Protection for Consumption of:	
		Acute	Chronic	Water + Organisms	Organisms Only
Arsenic	5.6 U	50	50	50	50
Cadmium[3]	0.22	16.6	2.9	NA	NA
Copper	2.47	62.8	37.1	NA	NA
Lead[3]	0.49 U	281	10.9	NA	NA
Mercury	0.02	2.1	0.012	0.14	0.15
Selenium	9.6 U	20	5	NA	NA
Silver	2.6 U	37.4	NA	NA	NA
Thallium	5.8	NA	NA	1.7	6.3
Zinc[3]	34.6	371	338	NA	NA

[1] Refer to Table 2-7 for the basis of State of Idaho values used in this table.

[2] Average concentrations for dissolved metals collected during the Phase 2 Treatability Study between July 16 and August 15, 2000. One half of the detection limit was used for values that were not detected.

[3] Freshwater and human health concentrations provided in this table are superseded by the source load allocations developed in the TMDL. The values are provided for comparative purposes only.

U = Not detected above the indicated detection limit of the analyses.

NA = Not available.

TABLE 5-3
Cost Summary for Alternative 2—Treatment Only
Bunker Hill Mine Water RI/FS Report

Remedy Component	Capital Cost ($)	Annual O&M Cost ($/yr)	30-Year Net Present Value[1] ($)
AMD Mitigations	0	0	0
AMD Collection	0	1,071,000	13,290,000
AMD Conveyance	340,000	130,000	1,953,000
AMD Storage	0	31,000	385,000
AMD Treatment	9,561,000	849,000	20,096,000
Sludge Management Option A	6,743,000[2]	46,000	7,314,000
Sludge Management Option B	5,590,000[2]	745,000	14,835,000
Sludge Management Option C	11,260,000[2]	72,000	12,153,000
Sludge Management Option D	10,239,000[2]	154,000	12,150,000
Performance Monitoring	0	78,000 (yrs 1-30)	968,000
Alternative 2A Totals	16,644,000	2,205,000	44,006,000
Alternative 2B Totals	15,491,000	2,904,000	51,527,000
Alternative 2C Totals	21,161000	2,231,000	48,846,000
Alternative 2D Totals	20,140,000	2,313,000	48,842,000

[1]The net present value is calculated using a 30-year analysis period and a 7 percent interest rate.
[2]Sludge management capital cost is the net present value of capital expenditures.

TABLE 5-4
Cost Summary for Alternative 3—Phased Mitigations/Treatment
Bunker Hill Mine Water RI/FS Report

Remedy Component	Capital Cost ($)	Annual O&M Cost ($/yr)	30-Year Net Present Value[1] ($)
AMD Mitigations	4,990,000	55,000	5,672,000
AMD Collection	0	1,071,000	13,290,000
AMD Conveyance	340,000	130,000	1,953,000
AMD Storage	1,950,000	157,000	3,898,000
AMD Treatment	8,198,000	797,000	18,088,000
Sludge Management Option A	6,474,000[2]	42,000	6,995,000
Sludge Management Option B	5,350,000[2]	682,000	13,813,000
Sludge Management Option C	10,937,000[2]	67,000	11,768,000
Sludge Management Option D	9,532,000[2]	141,000	11,282,000
Performance Monitoring	0	320,000 yrs 1-10 78,000 yrs 11-30	2,668,000
Alternative 3A Totals	21,952,000	2,572,000 yrs 1-10 2,330,000 yrs 11-30	52,565,000
Alternative 3B Totals	20,828,000	3,212,000 yrs 1-10 2,970,000 yrs 11-30	59,383,000
Alternative 3C Totals	26,415,000	2,597,000 yrs 1-10 2,355,000 yrs 11-30	57,338,000
Alternative 3D Totals	25,010,000	2,671,000 yrs 1-10 2,429,000 yrs 11-30	56,852,000

[1]The net present value is calculated using a 30-year analysis period and a 7 percent interest rate.
[2]Sludge management capital cost is the net present value of capital expenditures.

TABLE 5-5
Cost Summary for Alternative 4—Phased Mitigations/Treatment with Plugging of Near-Stream Workings
Bunker Hill Mine Water RI/FS Report

Remedy Component	Capital Cost ($)	Annual O&M Cost ($/yr)	30-Year Net Present Value[1] ($)
AMD Mitigations	6,000,000	56,000	6,695,000
AMD Collection	0	1,071,000	13,290,000
AMD Conveyance	340,000	130,000	1,953,000
AMD Storage	1,950,000	157,000	3,898,000
AMD Treatment	8,198,000	797,000	18,088,000
Sludge Management Option A	6,474,000[2]	42,000	6,995,000
Sludge Management Option B	5,350,000[2]	682,000	13,813,000
Sludge Management Option C	10,937,000[2]	67,000	11,768,000
Sludge Management Option D	9,532,000[2]	141,000	11,282,000
Performance Monitoring	0	320,000 yrs 1-10 78,000 yrs 11-30	2,668,000
Alternative 4A Totals	22,962,000	2,573,000 yrs 1-10 2,331,000 yrs 11-30	53,588,000
Alternative 4B Totals	21,838,000	3,213,000 yrs 1-10 2,971,000 yrs 11-30	60,405,000
Alternative 4C Totals	27,425,000	2,598,000 yrs 1-10 2,356,000 yrs 11-30	58,361,000
Alternative 4D Totals	26,020,000	2,672,000 yrs 1-10 2,430,000 yrs 11-30	57,874,000

[1]The net present value is calculated using a 30-year analysis period and a 7 percent interest rate.
[2]Sludge management capital cost is the net present value of capital expenditures.

TABLE 5-6
Cost Summary for Alternative 5—Treatment with All Mitigations
Bunker Hill Mine Water RI/FS Report

Remedy Component	Capital Cost ($)	Annual O&M Cost ($/yr)	30-Year Net Present Value[1] ($)
AMD Mitigations	12,060,000	222,000	14,815,000
AMD Collection	0	1,071,000	13,290,000
AMD Conveyance	340,000	130,000	1,953,000
AMD Storage	1,950,000	157,000	3,898,000
AMD Treatment	8,198,000	763,000	17,666,000
Sludge Management Option A	6,205,000	38,000	6,677,000
Sludge Management Option B	5,100,000	618,000	12,769,000
Sludge Management Option C	10,605,000	62,000	11,374,000
Sludge Management Option D	8,821,000	129,000	10,422,000
Performance Monitoring	0	320,000 yrs 1-5 78,000 yrs 6-30	1,960,000
Alternative 5A Totals	28,753,000	2,701,000 yrs 1-5 2,459,000 yrs 6-30	60,260,000
Alternative 5B Totals	27,648,000	3,281,000 yrs 1-5 3,039,000 yrs 6-30	66,352,000
Alternative 5C Totals	33,153,000	2,725,000 yrs 1-5 2,483,000 yrs 6-30	64,957,000
Alternative 5D Totals	31,369,000	2,792,000 yrs 1-5 2,550,000 yrs 6-30	64,005,000

[1]The net present value is calculated using a 30-year analysis period and a 7 percent interest rate.
[2]Sludge management capital cost is the net present value of capital expenditures.

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TABLE 5-7
Alternatives Evaluation Summary
Bunker Hill Mine Water RI/FS Report

Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume through Treatment	Short-Term Effectiveness	Implementability	Cost[1] (million $)
Alternative 1—No Further Action						
Does not protect. Results in discharge of untreated AMD and aquatic toxicity in Bunker Creek and the SFCdA River.	Does not comply with ARARs.	Takes no measures to reduce the long-term release of AMD from the mine and results in increased long-term human health risk and environmental harm by direct discharge of AMD to Bunker Creek.	Results in the existing treatment plant shutting down in 3 to 5 years, increasing the toxicity, mobility, and volume of AMD contaminants compared to current conditions.	Results in increased short-term risks. Never provides protection.	Will likely have low administrative feasibility because of the resulting environmental consequences from untreated AMD entering Bunker Creek and the SFCdA River.	Capital: $0 Annual O&M: $6.36 **Total NPV: $6.4**
Alternative 2—Treatment Only						
Protects by using storage and a large enhanced treatment plant; however, AMD flows are not reduced. Thus, there is potential for peak flows to exceed storage and treatment capacity.	Expected to comply with most Idaho surface water criteria and attain TMDLs.	Does not halt AMD generation or reduce flows. Although treatment is effective, it is needed indefinitely.	Uses treatment to reduce the toxicity, mobility, and volume of contaminants to acceptable levels. Treatment sludge requires long-term management. Treatment process could be reversed if sludge is dissolved.	Alternatives 2 through 5 are expected to provide about the same short-term protectiveness. The AMD will continue to be collected, stored, and treated using existing systems during construction of new systems.	Readily implementable. Uses existing and available technologies. No administrative difficulties. Adequate sludge storage available on or off-site. Require coordination with the mine owner to implement in-mine storage.	Capital: $15.5 – $21.2 Annual O&M: $2.21 – $2.90 **Total NPV: $44.0 – $51.5** **Lowest cost alternative (other than Alternative 1)**
Alternative 3—Phased Treatment/Mitigations						
Protects by use of mitigations to reduce AMD flows, use of an enhanced in-mine storage system, and use of an enhanced treatment plant. Phased implementation of mitigations and treatment capacity provides flexibility to increase protection if needed, and should provide more overall protectiveness than Alternative 2.	Similar to Alternative 2	Reduces long-term risk compared to Alternative 2 by using mitigations to reduce AMD flows, and an enhanced in-mine storage system. Indefinite treatment is still needed. Reduces sludge volume by about 10 percent compared to Alternative 2.	Uses the same treatment and sludge disposal methods as Alternative 2, but mitigations result in about 10 percent less AMD and sludge. Further reductions will occur if more mitigations are built using the phased approach.	Environmental impacts associated with Alternatives 3, 4, and 5 are greater than Alternative 2 because of impacts from mitigation construction.	Similar to Alternative 2, but additional coordination with the mine owner is required to implement in-mine AMD monitoring. Also requires coordination with landowners to implement mitigations.	Capital: $20.8 – $26.4 Annual O&M: $2.47 – $3.11 **Total NPV: $52.6 – $59.4**
Alternative 4—Phased Treatment/Mitigations with Plugging of Near-Stream Workings						
Similar to Alternative 3, but initially more protective since two additional mitigations are constructed.	Similar to Alternative 2	Similar to Alternative 3	Similar to Alternative 3	Similar to Alternative 3	Similar to Alternative 3	Capital: $21.8 – $27.4 Annual O&M: $2.47 – $3.11 **Total NPV: $53.6 – $60.4**
Alternative 5—Treatment with All Mitigations						
Does not use a phased approach and has less flexibility compared to Alternatives 3 and 4. This lack of flexibility reduces its ability to protect as compared to Alternatives 3 and 4.	Similar to Alternative 2	Similar to Alternatives 3 and 4, but since a phased approach is not used, it is possible that the additional mitigations initially implemented may not substantially increase overall remedy effectiveness.	Similar to Alternatives 3 and 4, but mitigations result in about 20 percent less AMD and sludge than Alternative 2.	Similar to Alternative 3	Similar to Alternative 3	Capital: $27.7 – $33.2 Annual O&M: $2.54 – $3.12 **Total NPV: $60.3 – $66.4** **Highest cost alternative**
Sludge Options						
All four sludge options are expected to be protective of the community and the environment.	All four sludge management options are expected to be in compliance with all ARARs.	All four sludge management options are expected to have adequate and reliable controls to prevent migration of contaminants and public exposure. Option D requires about 300 to 600 truckloads of sludge to be hauled each fall along McKinley Avenue from the CIA drying beds to the smelter closure area landfill. Although the trucks would be decontaminated, this volume of truck traffic could be disruptive.	All three onsite options (A, C, and D) use engineering controls or land use restrictions to isolate and protect the sludge from disturbance. The offsite option (B) will use appropriate disposal facilities to ensure that the sludge is properly managed.	The onsite sludge options (A, C, and D) are expected to have about the same construction impacts on the community. Option B, the off-site option, will have minimal community construction impacts because all construction occurs at the CTP.	Onsite sludge options (A, C, and D) would be constructed on federally owned land. Option C more difficult to implement than options A and D because of the sludge pump station and pipeline along McKinley Ave. Sufficient regionally available off-site sludge disposal capacity exists for Option B.	Of the four sludge options, Option B, which uses mechanical dewatering and offsite disposal, is the most costly. Option A, which uses CIA sludge disposal beds, is the least costly. Options C and D have about the same cost.

[1]The cost of each alternative depends on which sludge option is selected. 30-year net present values use a 7 percent interest rate to convert future costs to present cost.

AMD = acid mine drainage

SFCdA = South Fork Coeur d'Alene (River)

ARAR = applicable or relevant and appropriate requirement

TMDL = total maximum daily load

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TABLE 5-8
Alternative Summary Descriptions
Bunker Hill Mine Water RI/FS Report

Alternative	Description
1—No Further Action	• No mitigations are constructed • Uses the existing AMD collection, conveyance, storage, treatment, and sludge management systems • CTP is not upgraded or repaired. The CTP is shut down in 3 to 5 years when the existing sludge disposal capacity is exhausted.
2—Treatment Only	• No mitigations are constructed • Uses existing AMD collection, conveyance, and storage systems • Pipeline added for direct flow capability to CTP • CTP upgraded to 5,000 gpm capacity with filters for high-density sludge (HDS) operation, attainment of TMDLs, and compliance with discharge standards. • Alternative 2A uses new CIA sludge disposal beds. Alternative 2B uses mechanical sludge dewatering and offsite disposal. Alternative 2C uses sludge disposal beds located above the smelter closure area. Alternative 2D uses CIA sludge drying beds and annual excavation and disposal in a landfill located above the smelter closure area. Alternatives 2A, 2C, and 2D are estimated to produce about 5,400 y^3/yr of sludge. Alternative 2B is estimated to produce about 10,300 y^3/yr of sludge because the mechanical dewatering is expected to be less efficient than sludge drying beds or sludge disposal beds.
3—Phased Mitigations/Treatment	• Uses a phased implementation and performance evaluation approach for mitigations and CTP sizing. Following initial actions, up to 10 years of monitoring and performance evaluation is used to determine if more mitigations or treatment capacity is needed. • Initially implements the West Fork Milo Creek Diversion, rehabilitates the Phil Sheridan Diversion, and plugs in-mine drill holes, which collectively are expected to significantly reduce peak mine water flows. Total annual volumes are expected to be reduced by about 10 percent by initial mitigations. • Uses existing AMD collection and conveyance with pipeline added for direct flow capability to CTP • Uses existing lined pond and new gravity diversion system into in-mine storage. Also includes new mine pool extraction pumps. • The initial CTP hydraulic and neutralization capacity is 5,000 gpm. The initial filtration capacity is 2,500 gpm. Lime consumption is expected to be reduced by 10 percent by initial mitigations. • Uses one of the four sludge disposal options described for Alternative 2. The sludge volume is expected to be initially 10 percent less than Alternative 2 because of the mitigation-induced AMD volume reduction.
4—Phased Mitigations/Treatment with Plugging of Near-Stream Workings	• Similar to Alternative 3, except plugs are initially placed in the Small Hopes drift below Mainstem Milo Creek, and in the Inez Shaft below Deadwood Creek. These will reduce or eliminate the potential for stream erosion into the underlying mine workings. These two mitigations would be implemented under Alternative 3 if needed, based on the monitoring program and the phased approach.
5—Treatment with All Mitigations	• Similar to Alternatives 3 and 4, except a phased approach is not used. All mitigations (see Table 4-4) are implemented initially, and the CTP is sized at 2,500 gpm with no potential phased expansion. Mitigation performance monitoring is conducted for 5 years, then stopped.

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TABLE 5-9
Summary of Costs
Bunker Hill Mine Water RI/FS

Alternative	Capital Costs (million $)	Annual O&M Costs[1] (million $)	30-Yr NPV[2] O&M Costs (million $)	30-Yr NPV[2] Total Costs (million $)
Alternative 1—No Further Action (4-year NPV)				
1—No Further Action	0	1.88 (Yrs 1-4)	6.4	6.4
Alternative 2—Treatment Only				
2A—with CIA Sludge Disposal Beds	16.6	2.21 (Yrs 1-30)	27.4	44.0
2B—with Mechanical Sludge Dewatering and Offsite Disposal	15.5	2.90 (Yrs 1-30)	36.0	51.5
2C—with Smelter Closure Area Sludge Disposal Beds	21.2	2.23 (Yrs 1-30)	27.7	48.8
2D—with CIA Sludge Drying Beds and Smelter Closure Area Sludge Landfill	20.1	2.31 (Yrs 1-30)	28.7	48.8
Alternative 3—Phased Mitigations/Treatment				
3A—with CIA Sludge Disposal Beds	22.0	2.57 (Yrs 1-10) 2.33 (Yrs 11-30)	30.6	52.6
3B—with Mechanical Sludge Dewatering and Offsite Disposal	20.8	3.21 (Yrs 1-10) 2.97 (Yrs 11-30)	38.6	59.4
3C—with Smelter Closure Area Sludge Disposal Beds	26.4	2.60 (Yrs 1-10) 2.36 (Yrs 11-30)	30.9	57.3
3D—with CIA Sludge Drying Beds and Smelter Closure Area Sludge Landfill	25.0	2.67 (Yrs 1-10) 2.43 (Yrs 11-30)	31.8	56.8
Alternative 4—Phased Mitigations/Treatment with Plugging of Near-Stream Workings				
4A—with CIA Sludge Disposal Beds	23.0	2.57 (Yrs 1-10) 2.33 (Yrs 11-30)	30.6	53.6
4B—with Mechanical Sludge Dewatering and Offsite Disposal	21.8	3.21 (Yrs 1-10) 2.97 (Yrs 11-30)	38.6	60.4
4C—with Smelter Closure Area Sludge Disposal Beds	27.4	2.60 (Yrs 1-10) 2.36 (Yrs 11-30)	30.9	58.3
4D—with CIA Sludge Drying Beds and Smelter Closure Area Sludge Landfill	26.0	2.67 (Yrs 1-10) 2.43 (Yrs 11-30)	31.9	57.9
Alternative 5—Treatment with All Mitigations				
5A—with CIA Sludge Disposal Beds	28.8	2.70 (Yrs 1-5) 2.46 (Yrs 6-30)	31.5	60.3
5B—with Mechanical Sludge Dewatering and Offsite Disposal	27.6	3.28 (Yrs 1-5) 3.04 (Yrs 6-30)	38.7	66.4
5C—with Smelter Closure Area Sludge Disposal Beds	33.2	2.73 (Yrs 1-5) 2.48 (Yrs 6-30)	31.8	65.0
5D—with CIA Sludge Drying Beds and Smelter Closure Area Sludge Landfill	31.4	2.79 (Yrs 1-5) 2.55 (Yrs 6-30)	32.6	64.0

[1]The annual O&M costs for Alternatives 3 and 4 is higher the first ten years due to the mitigation performance monitoring assumed to be conducted the first ten years as part of the phased approach. Alternative 5 assumes only 5 years of mitigation performance monitoring.

[2]The 30-yr Net present Value (NPV) costs are calculated using a 7 percent interest rate.

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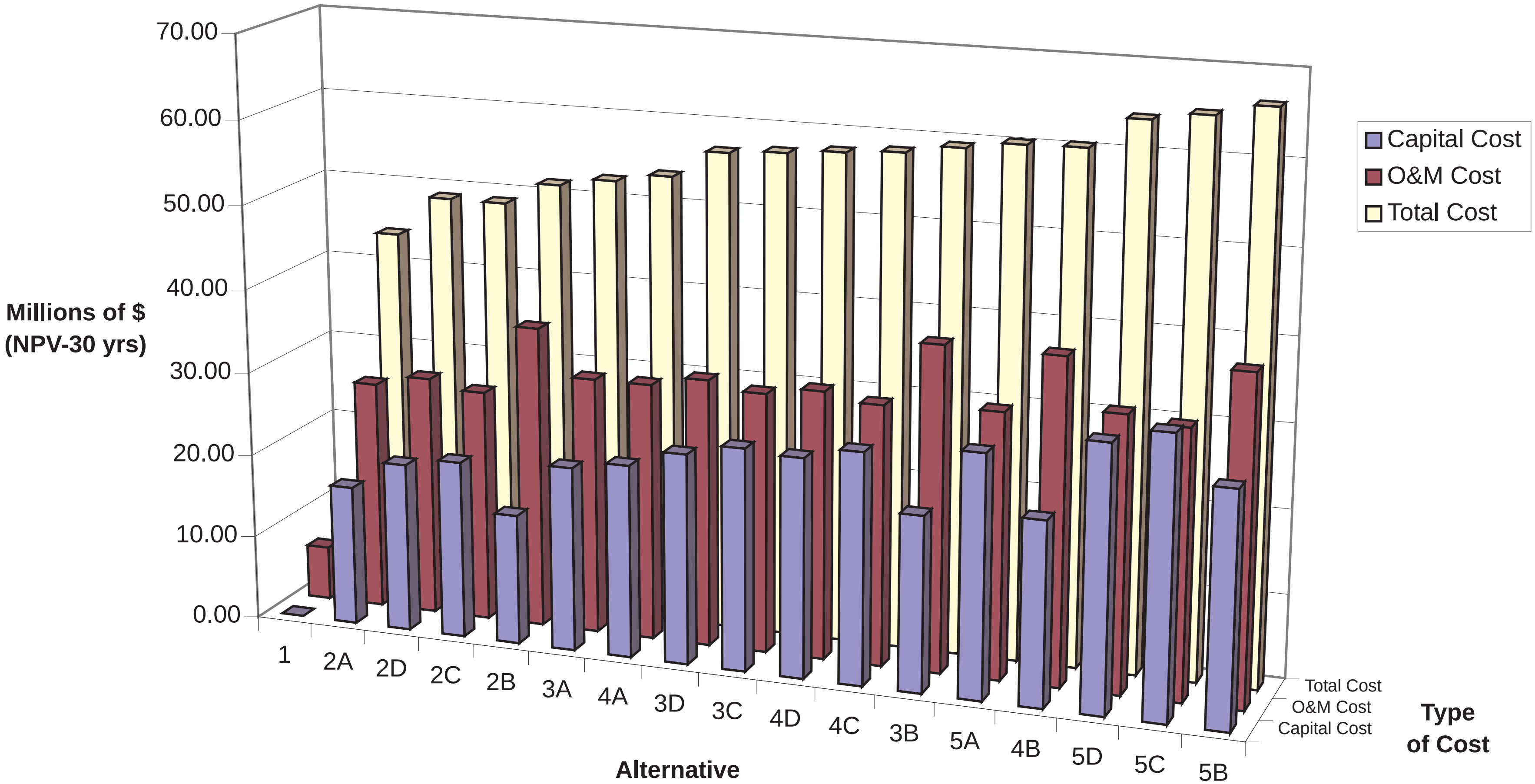

FIGURE 5-1
ALTERNATIVE COST COMPARISON ARRANGED FROM LOWEST TO HIGHEST COST TOTAL
BUNKER HILL MINE WATER MANAGEMENT RI/FS

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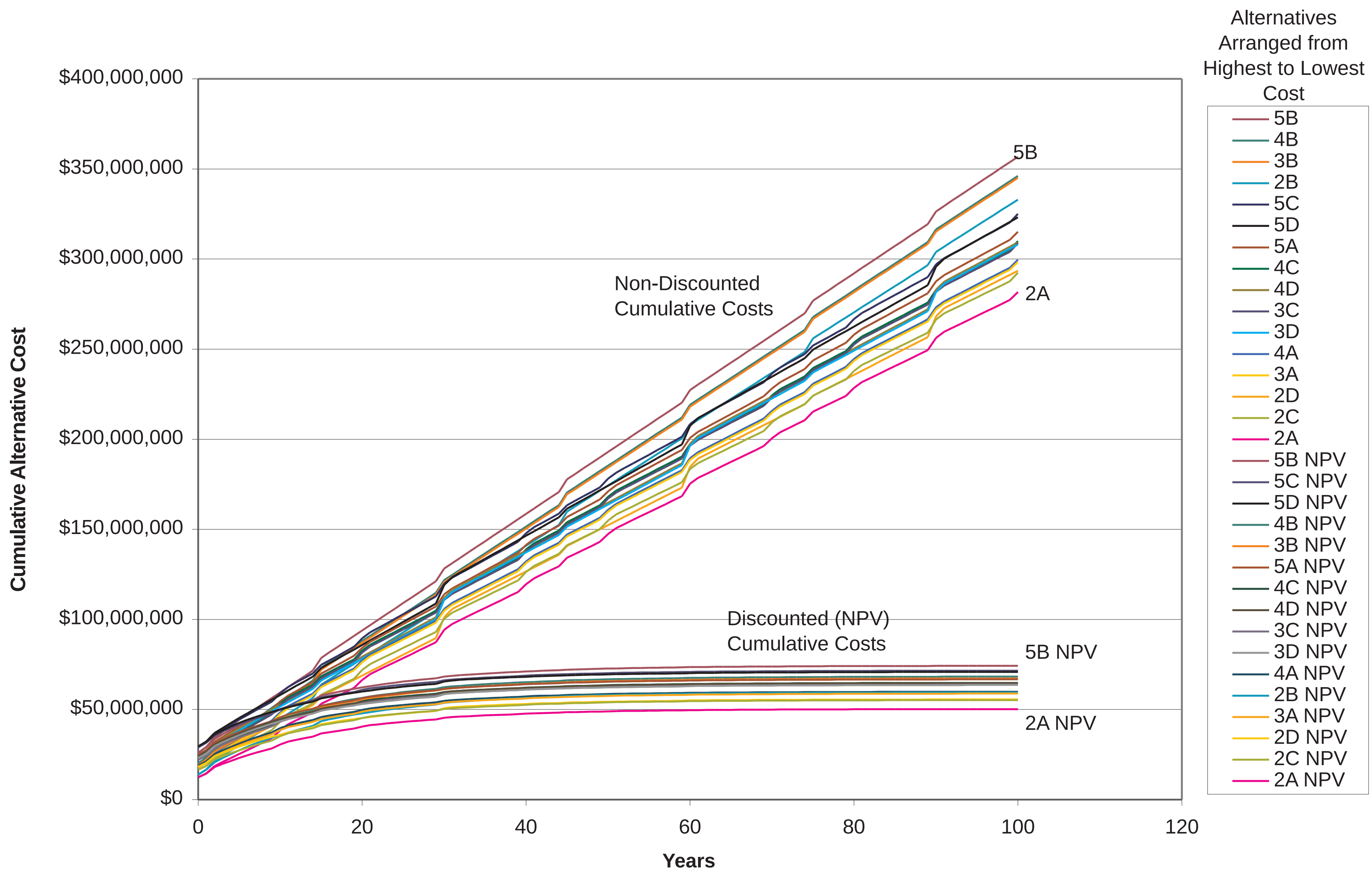

FIGURE 5-2
100-YEAR NON-DISCOUNTED AND DISCOUNTED (NPV) CUMULATIVE COST
BUNKER HILL MINE WATER MANAGEMENT RI/FS

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